INSTRUCTION MANUAL

USB – 8K MCA

TYPE: MC1001

NUCLEONIX SYSTEMS PRIVATE LIMITED

Plot No: 162 A & B, Phase II, I.D.A. Cherlapally, Hyderabad - 500 051.
Phone: 040-29706483 / 84 / 85 , Mobile No: 7331104481 / 82
E-mail: info@nucleonix.com Web : www.nucleonix.com

FILE NAME : NSPL/DOC / MAN / MC1001/01
VER_20160517

Head of the Dept.

Approved By

Contents

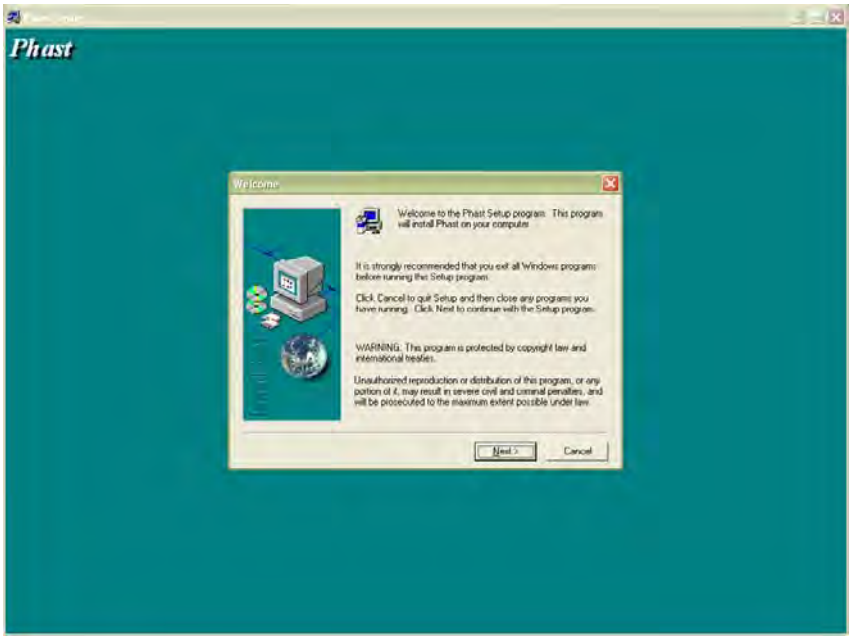
Important note:
In this processing software, ‘activity calculation’ and ‘Isotope search library’ are meant to be used, for processing of PHA spectra acquired using Germanium detector. Application of these functions for spectra acquired with NaI scintillation detector will not work satisfactorily and hence is to be avoided.

CHAPTER – I

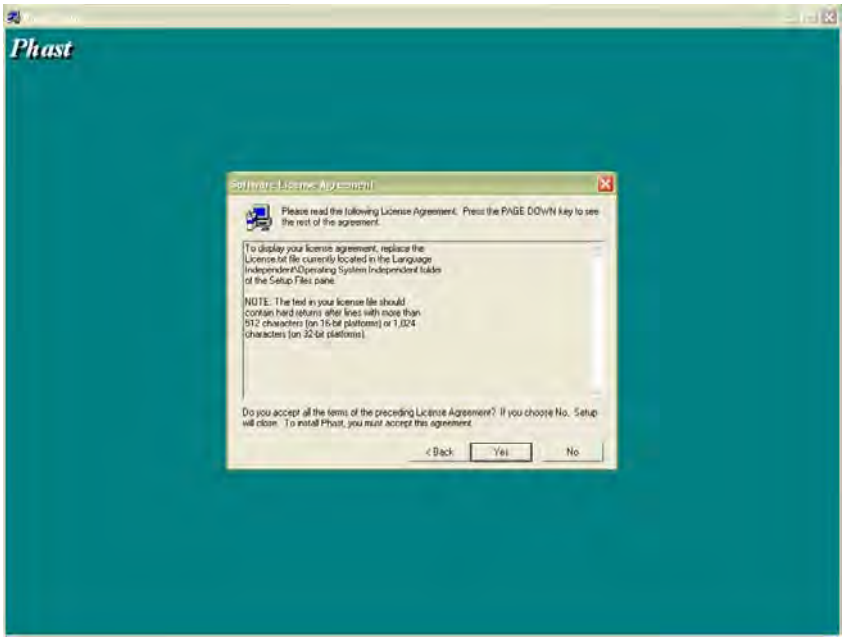
INSTALLATION

SOFTWARE:

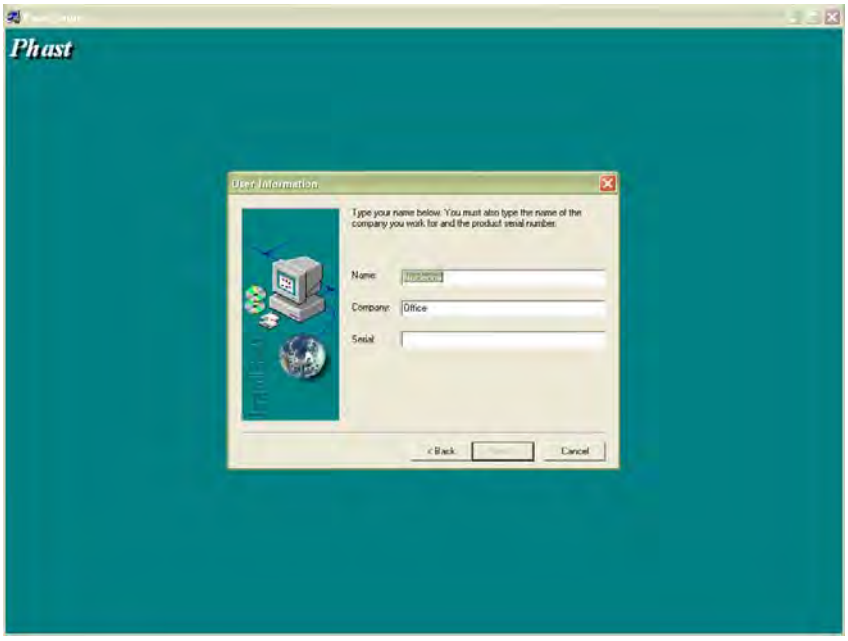
Insert the 8K-MCA Setup CD provided and Run the “Setup.exe” file. This will invoke the installation program and the following screen shows up.



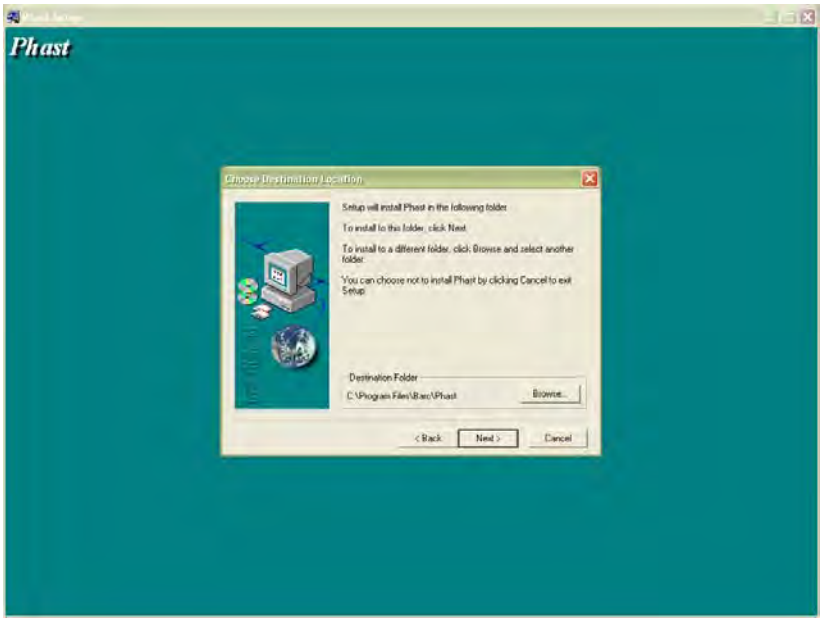
To continue with the installation, click on “Next”.
The next screen, which appears, is as follows. SD



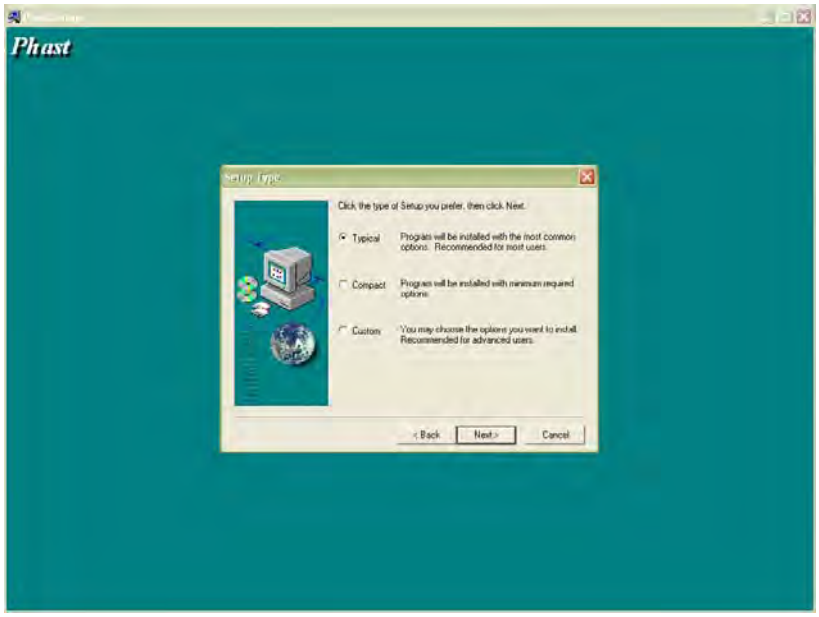
Click on the “Yes”



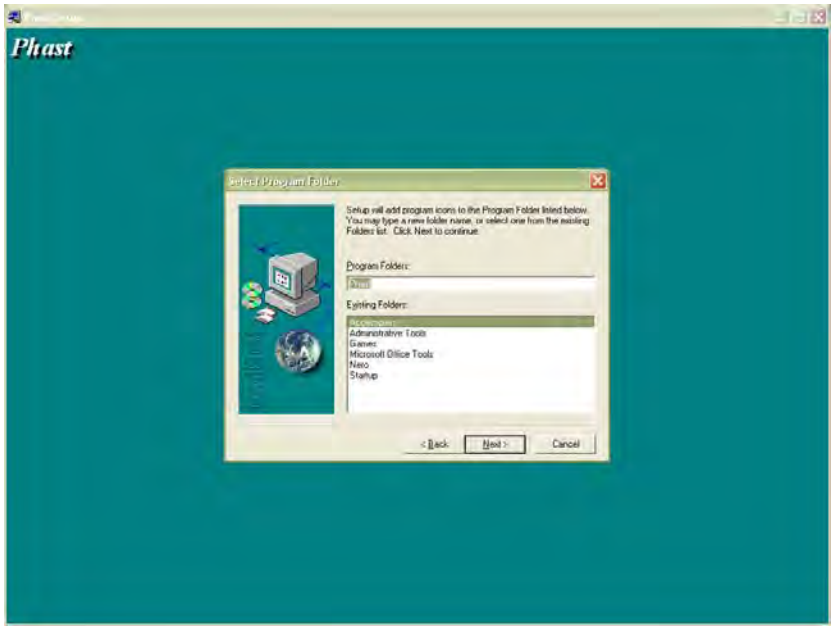
Now enter the “serial no” of the card (default is 1).
The following screen appears next



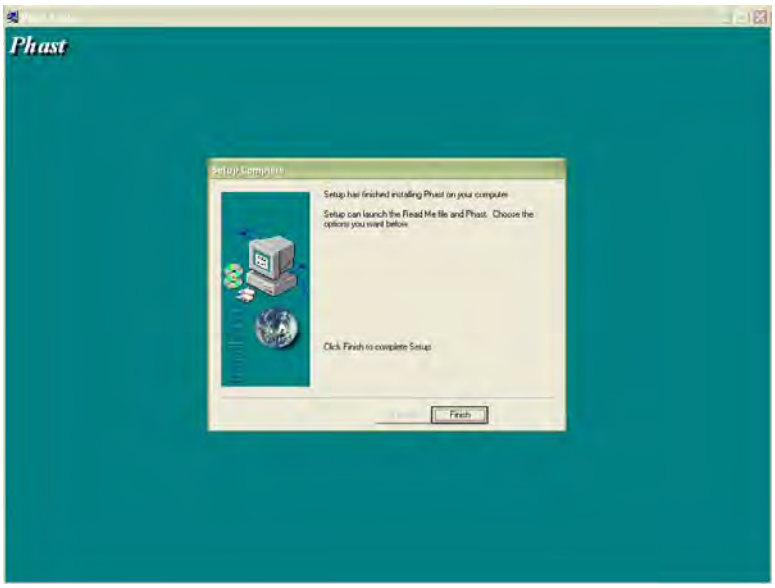
Note: The User is asked not to modify the default path of installation as this leads to improper functioning of the software.



Click on “Next” button



By pressing the Next button the setup will now install the software.
At the end of the installation the following screen is displayed



This marks the end of the installation procedure. Click finish to end the installation. To run the software the user has to click the

"C drive → Program files → Barc → Phast"

Now connect the card to PC. The driver initialization of the USB device is to be done as follows:

1) The .inf file "Ezusbw2k.inf" on the setup CD has to be copied to operating system in folder WINNT -> inf or WINDOWS -> inf folder.

2) The .sys file "ezusb.sys" on the setup CD has to copy to the folder WINNT -> System32->drivers or WINDOWS -> System32 >drivers of the operating system. This finishes the software installation. The hardware may be plugged to the USB port to check the driver details by going to "Universal Serial Bus Controller" in Windows device manager in the settings -> Control Panel -> system -> hardware menu. The MCA will be shown as "Cypress EZ-USB Sample Device".

CHAPTER - II

GENERAL DESCRIPTION

INTRODUCTION :

A Multi-Channel Analyzer (MCA) is an important part of nuclear spectroscopy system. The major requirement of MCA is for nuclear pulse height analysis in energy spectroscopy. The USB-MCA presented here, incorporates state of art technologies like FPGA, USB bus interface and precision analog electronics to meet the stringent system requirements in nuclear pulse spectroscopy.

The resolution supported by the USB-MCA ranges from 256 channels to 8K channels selectable via software, making it suitable for all spectroscopy applications from low resolution (e.g. NaI-PMT) to high resolution (e.g. HP-Ge) systems.

The USB bus interface of the MCA provides an excellent connectivity with most of the new PCs and laptop computers. The ***PHAST*** application software provided with the USB-MCA, seamlessly integrates with the hardware, featuring a range of standard functions required for analysis and acquisition.

Thus the USB-MCA, along with external HP-Ge detector, spectroscopy amplifier and HV supply, forms a complete system for high-resolution spectroscopy applications.

A Multi channel analyzer MCA is an important part of the system and it can have various modes of nuclear data acquisition, such as Pulse Height Analysis (PHA), List and Multi-Channel Scaling (MCS). Among these operating modes, the MCS (Multi-Channel Scaling) mode records the counting rate of events as a function of time, which is required for various applications such as mossbauer spectroscopy and other time related isotope studies.

In order to operate the system in MCS mode, various MCS parameters are set through the application software PHAST-MCS. The USB-MCA has internal pre-settable dwell timer to perform internal channel advancing as well as for generating time-base output signal for external hardware. It accepts Sync input from an external hardware such as a drive unit, and accepts shaped analog input pulses from an external amplifier. The analog signal is qualified by an on-board SCA before actual MCS counting. The use may refer to the various specifications given for the operation.

A figure-1 below shows a block diagram of general arrangement for high-resolution nuclear spectroscopy:

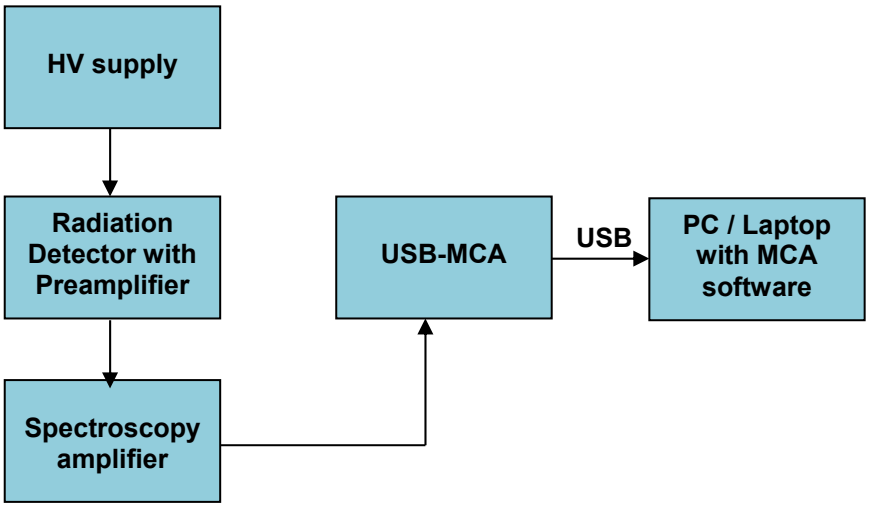


Fig.1. General arrangement for high-resolution nuclear spectroscopy

The HV and spectroscopy amplifier are commercially available standard modules, which normally reside in a NIM bin and a high-resolution HP-Ge semiconductor detector with cooling arrangement and pre-amplifier is the front-end for the spectroscopy system. The output of the spectroscopy amplifier is fed to the USB-MCA for further data processing. The USB-MCA has state of the art USB interface for communicating with a PC / laptop, and it stays out of a PC cabinet unlike the other MCAs based on ISA or PCI bus.

In the USB-MCA, most of the digital circuitry, including memory controller, bus arbitration logic, sequencers, buffers, ADC interface, sliding scale correction logic, counters, timing and functional controls, PC bus interface, etc. are integrated using a single FPGA type Xilinx XC2S200, a 200K gate FPGA. The FPGA offers many advantages like low power, small size, better reliability; low cost, easier design modifications, etc. Most importantly, the complexity of present designs rules out any use of discrete logic circuits.

In addition to the digital side, the entire analog part of the circuit including monolithic ADC uses isolated power supplies, which are derived from +5 V PC power supply using DC-DC converters and regulators. Use of such power supplies and ground scales down the effect of noise associated with digital switching circuits and SMPS etc, resulting into superior performance. The MCA accepts input from a Spectroscopy Amplifier for Pulse Height Analysis and offers all features of a Research grade standalone 8K MCA.

APPLICATIONS :

The USB-MCA is useful for high-resolution x-ray and gamma ray spectrometry work in following areas:

- Isotope research
- Nuclear reactors
- Accelerators
- Universities
- Other R&D
- High count rate systems (with a typical dead time of 7 us maximum)
- Health physics instrumentation and other applications with lower resolution detectors like Na-I – PMT.

The USB-MCA has local spectrum memory, which makes the PHA spectrum (histogram) directly available for display. Thus the processor overheads for spectrum building are avoided, making the MCA very suitable for embedded systems with limited processing power. Also the spectrum is protected from being erased by program termination or any other reason (except PC cold boot) unless directed to do so. Thus the older data can be further reused.

The input pulse rate supported is up to 100 KHz, making the card useful for high-count rate applications. The data rate can be further increased with the penalty of increased system dead time.
The CMOS digital circuits and low power analog circuits used in the MCA make it a low power system, suitable for portable instruments as well as for high end laboratory instruments.

The resolution supported by the MCA ranges from 256 channels to 8K channels, in 6 steps selectable via software by the user. This makes the card suitable for all spectroscopy applications from low resolution (e.g. NaI-PMT) to high resolution (e.g. HP-Ge) systems.

The USB-MCA is designed with state of art technologies to meet the stringent requirements of nuclear instrumentation and hence offers many distinct advantages including the following:

- Excellent MCA performance in terms of resolution, DNL, etc.
- Universal connectivity to a wide range of PCs and notebook computers
- Unlike ISA / PCI cards, it stands outside a PC
- Simple to install, operate and handle
- Low power operation, operates with USB bus power only
- Suitable for portable as well as laboratory class instrumentation

SPECIFICATIONS :

Following are the specifications for the USB-MCA:

- MCA resolution : 256, 512, 1K, 2K, 4K and 8K channels
- Spectrum memory : 128 K bytes single port SRAM
- Max counts / channel : 31 bit (2 Giga counts)
- Pulse processing time : 7μs including ADC conversion time of 5 μs
- Pile up rejection : Active high TTL input from spectroscopy amplifier
- DNL : Better than ± 1 %
- INL : Better than ± 0.05 % F.S.
- MCA Input : Single channel, 0 to +10 volts
- Timer : 32 bit, integrated in FPGA
- Preset Time : LIVE or CLOCK, 1 sec to 136yrs
- LLD, ULD, Baseline : Digitally set through software
- Power requirement : 5V, ~ 500 mA through USB cable directly (No external power supply required)

Following are the specifications for the MCS function integrated in the USB-MCA :

- Analog input type : Positive, unipolar, gaussian shaped analog pulses from external amplifier
- Analog input range : 0 to +10V, 100 KHz maximum, with min 1□S shaping time constant
- Counts / channel : 31 bits max (2 Giga counts)
- Dwell time setting : 10 □s to 999 seconds, internal dwell timer for performing channel advance operation
- Time-base output : 1 □s active-high LVTTL pulse output driven by internal (on-board) dwell timer
- Sync pulse input : External, 1□□s active-high LVTTL input
- Pass length (channels) : 1K (1024) channels fixed
- Acquisition mode setting : Add or Overwrite previous count
- Acquisition timer setting : 99,99,99,999 seconds max.
- LLD, ULD levels setting : 100mV to 10V, set through software or on-board potentiometers
- Power requirement : 5V ~500mA, through USB cable

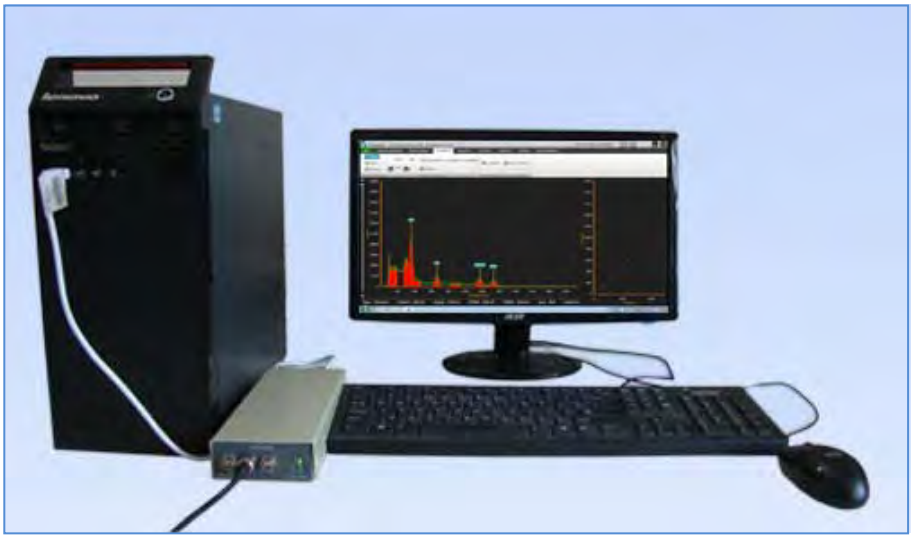
Connectors (All BNCs) :

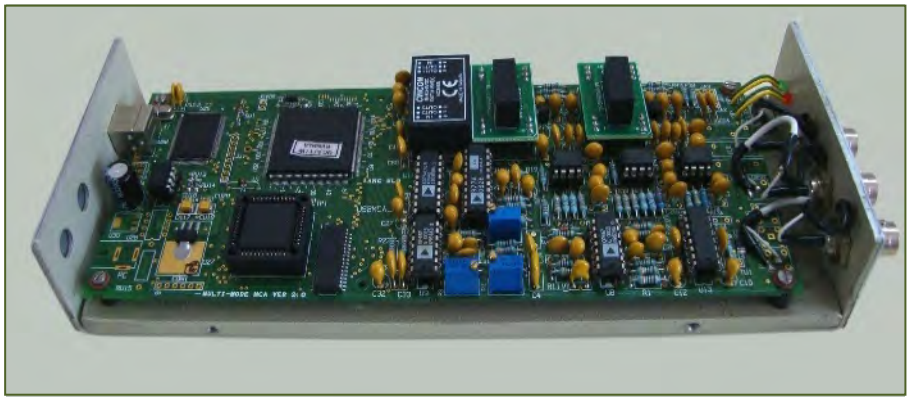
Front Panel

PUR: Pile- up reject input
INP: Linear pulse input
SCA : Internal single channel analyzer output

Rear Panel:
Time base : Output
MCA start (ext) : Input

PHOTOGRAPHS OF THE USB MCA:





CHAPTER - III

OPERATING PROCEDURE

A) THE PHAST APPLICATION SOFTWARE FOR MCA :

Application software namely ***PHAST*** is required for MCA data acquisition and analysis. It seamlessly integrates with the hardware and has all useful functions of acquisition and analysis. Some of the software features include:

- Automatic location and area determination of up to 500 peaks
- Energy, shape and efficiency calibration
- Nuclide identification and activity determination
- Available for Microsoft windows & Linux

The USB-MCA unit must be connected before invoking the ***PHAST*** application software on PC.

B) GRAPHICAL USER INTERFACE :

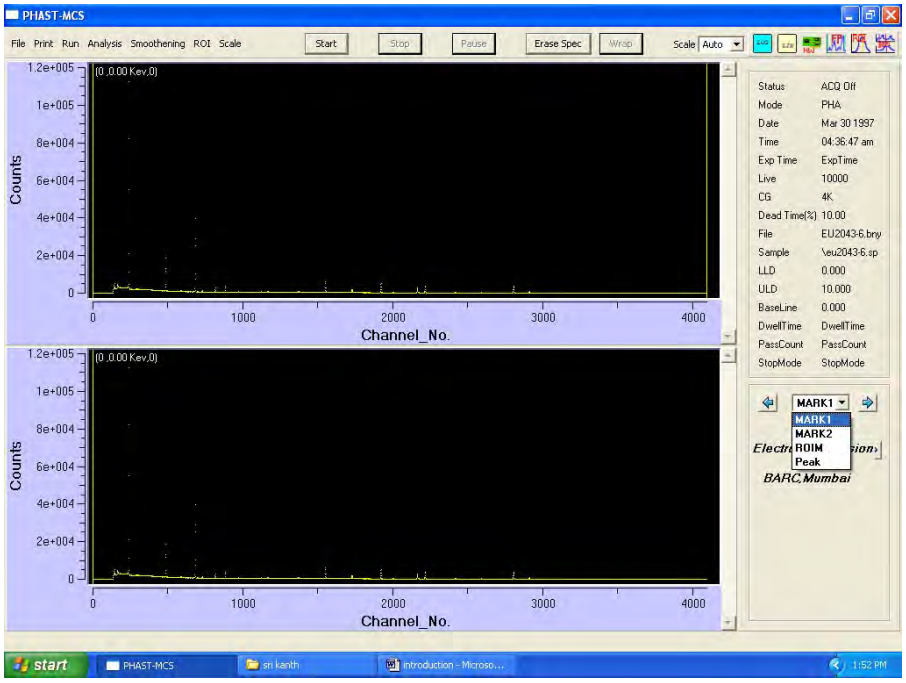


Figure: Main screen of the acquisition and analysis software

The main screen at the start of the program is as shown in figure above. There are two windows where the spectra are displayed. The upper window shows the entire spectrum while the lower window shows the expanded region between the cursors in the upper window (ROI). The upper cursors can be moved either by dragging using a mouse or by the two buttons (Mark1 for cursor 1 and Mark2 for cursor2) provided on the right side of the screen. The ROI cursor (lower display) may be move within the ROI by left right arrow keys. The 'Start' and 'Stop' buttons are used to start and stop the acquisition respectively. The same also is available as sub menu items under the menu 'RUN'.

C) STANDARD PROCEDURES:

(i) File Menu:

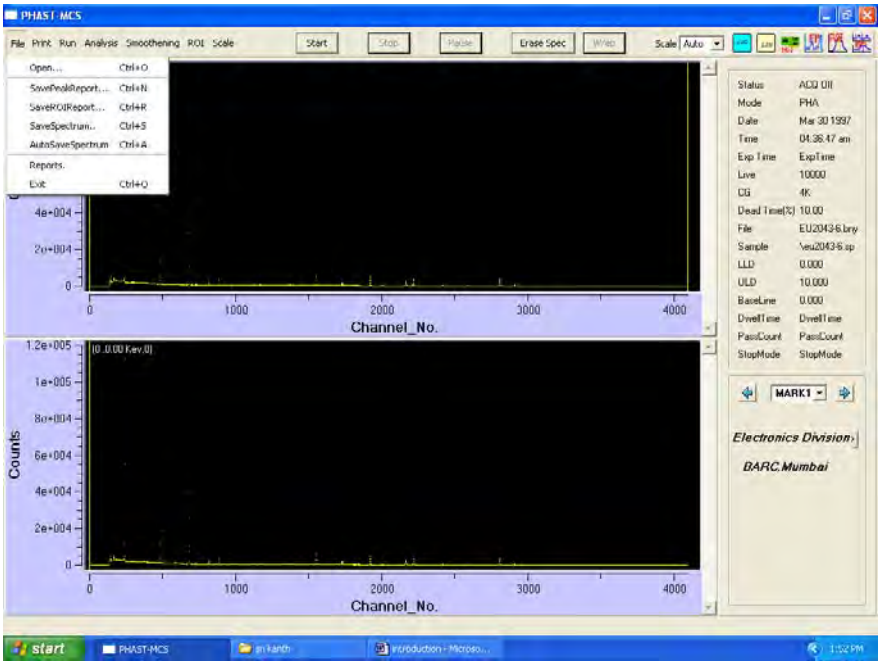
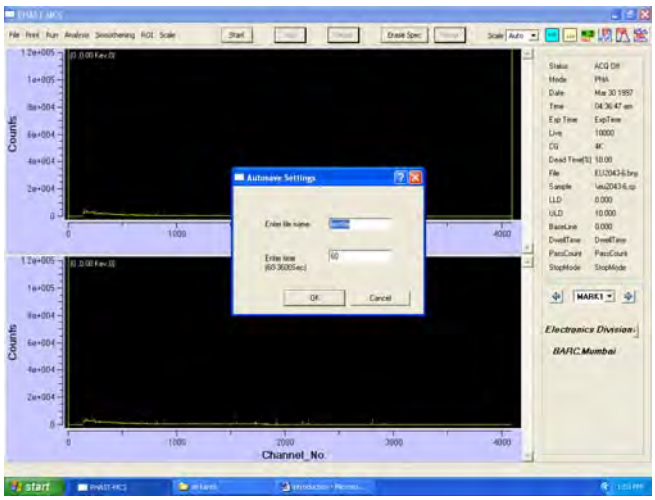


Fig: File Menu displayed

Open: The 'Open' is used for opening a spectrum file – it can be a text file with extension '. txt' or a binary file with extension'. bny'.
Save peak: One can save the peak report (described later) data using 'Save peak' menu item.
Save spectrum: This used for saving an acquired spectrum – this will create files in text format and binary format. An .org file is also generated which can be used with Origin software.
Save ROI: This is used to save the ROI information in a file.
Auto Save spectrum : This is used for periodically saving the spectrum automatically for the given time (in seconds) with a specified filename as shown in the figure.

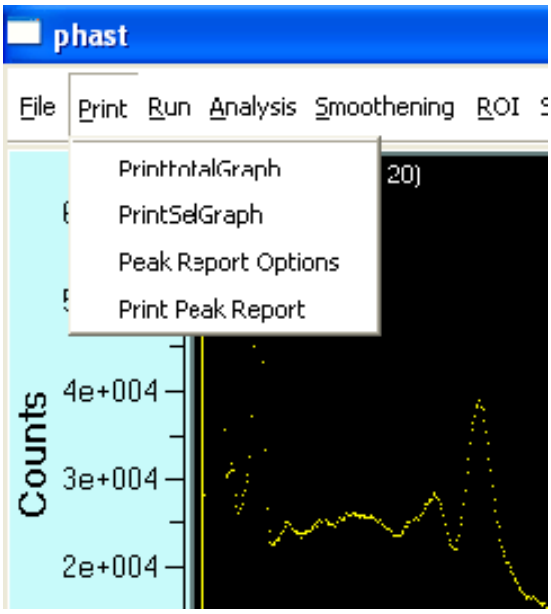


This helps from loosing the data in case of power failure
Note : This option is selected before starting the acquisition.

Reports: This menu item opens up an editor, which can be used to open and edit the different reports generated by the software.
Exit: Exit from the program. Any acquired spectrum, if not saved, will lead to a confirmation prompt.

(ii) Print Menu

The different menu items available under 'Print' are described below.



Print total Graph
This will result in hard copy of the Full spectrum (the upper window)

Print Sel Graph
This will result in hard copy of the ROI window (lower graph)

Peak Report Options

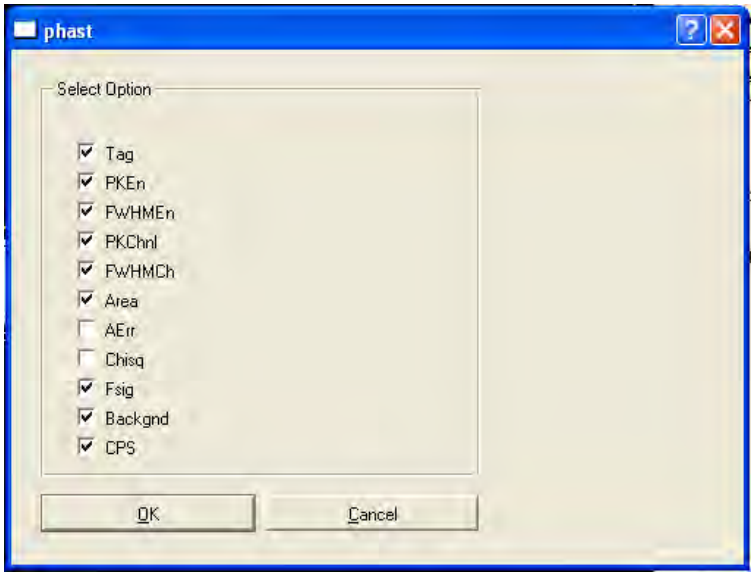


Fig: Configuration panel for peak report hard copy

This window will permit selection of various columns for the peak report – the user can do this selection as per his requirement. The options are saved in the installation directory. Subsequent peak report hard copies will be generated as per the options given here. In this we can select 9 options only, more than 9 are not allowed.

Print Peak Report
This is used for generating a hardcopy of the peak report as per the Menu.

(iii) Run Menu

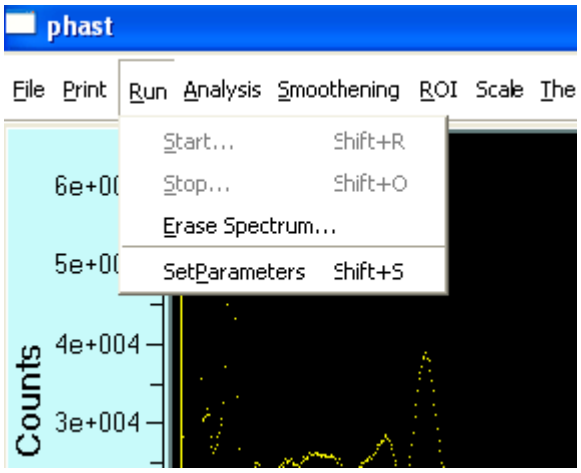


Fig: Run Menu Displayed

Start
This for starting acquisition (same as the button provide). This will be enabled only when the MCA is connected. On pressing start, a prompt appears to check whether data buffer has to be erased or not.

Stop
To stop the acquisition; will be enabled only after the start of acquisition.

Erase Spectrum
This can be used o clear the spectra buffer for starting a fresh acquisition.

Set Parameters
This is for setting various hardware parameters and an identifier for the spectrum (different from the spectrum file name) like sample name.

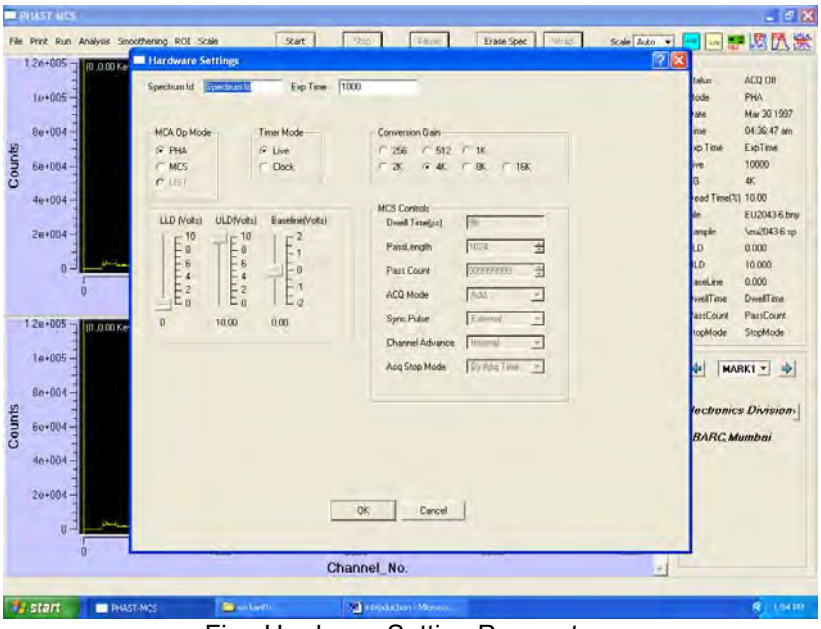


Fig: Hardware Setting Parameters

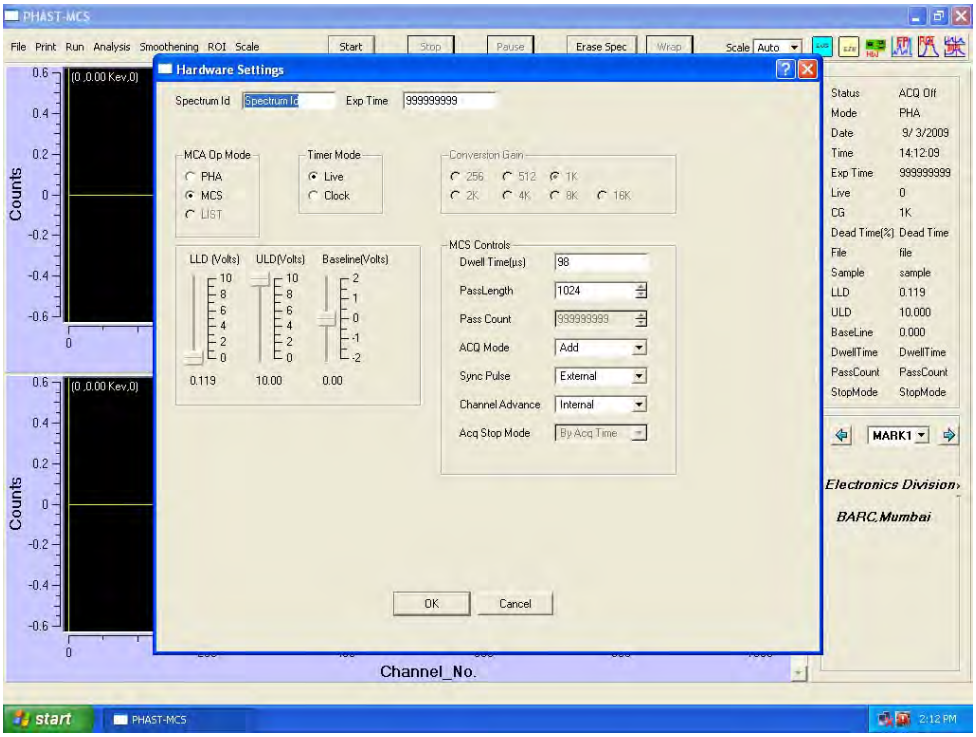
The parameters that can be set are conversion gain, live time or clock time, time in seconds, whether PHA/ MCS modes of operation.

The various parameters to be set are :

1. Spectrum ID : The identifier for the spectrum (Default : Spectrum ID)
2. Exp Time : The time for acquisition in seconds (for PHA and MCS both)
3. Timer Mode : Live / clock mode (for PHA only) (Default : Live)
4. Conversion Gain : This is used to set conversion gain of the MCA. (for PHA only) (Default : 1K)
5. LLD (volts) : This is used to set lower discrimination level of the MCA (Set range : 0.1 to 10 volts)
6. ULD (volts) : This is used to ser upper level discrimination level of the MCA (set range : 0.1 to 10 volts)
7. Baseline (volts) : This is used to set baseline of the MCA (range : 2 to 2 volts)
8. MCA Op mode : Select the MCA operation mode as PHA or MCS.

   For the PHA mode, the MCS controls parameters are disabled and for the MCS mode, the conversion gain is disabled (Default : PHA)

The hardware settings window for various MCS control parameters is as shown below :



It has the following parameters :

1. Dwell Time : MCA supports dwell time of 10ms to 999 seconds. (default : 98□S)
2. Pass Length : Displays the no. of channels for one sweep. (1024 channels fixed)
3. Max Pass Count : Displays the maximum number of MCS cycles supported by MCS. This number is fixed and should be taken as an information.
4. AQC Mode : Add / Overwrite (Default : Add)
   Add : Sums the previous counts and present counts on channel to channel basis.
   Overwrite : Replaces the previous counts with fresh counts on channel to channel basis.
5. Sync pulse : Internal / External (Default : External)
   External : Sync pulse is applied through external hardware (only this option is supported for actual use).
   Internal : Not supported (only for debugging)
6. Channel Advance : Internal / External (Default : Internal)
   Internal : The channel advance is realized by internal hardware dwell timer (only this option is supported for actual use).
   External : Not supported.
7. Acq stop mode : By Acq time only
   Acquisition stops when the preset acquisition time (exp time) is completed.

Set the required parameters and then click OK.
Then the acquisition can be started by clicking the START tab on the screen.

Important information about MCS settings :
From the user point of view it should be noted that, in case of some of the MCS settings shown in the settings window, only default values are supported by the MCS hardware.
These fixed settings are as follows :
Pass length (=102), pass count (=max), sync pulse (=external), channel advance (=internal) and Acq stop mode (=by Acq time). The user can not change these settings to other options / values, as the other options are unsupported and reserved only for debugging purpose.
Remaining MCS settings in the window are fully selectable by user. These are :
Exp time, dwell time, Acq mode and MCA op mode. The user can change these settings as required as per the specifications, through for most of the times the defaults would suffice.

Various information displayed
The status window on the main screen is as shown in the figure :

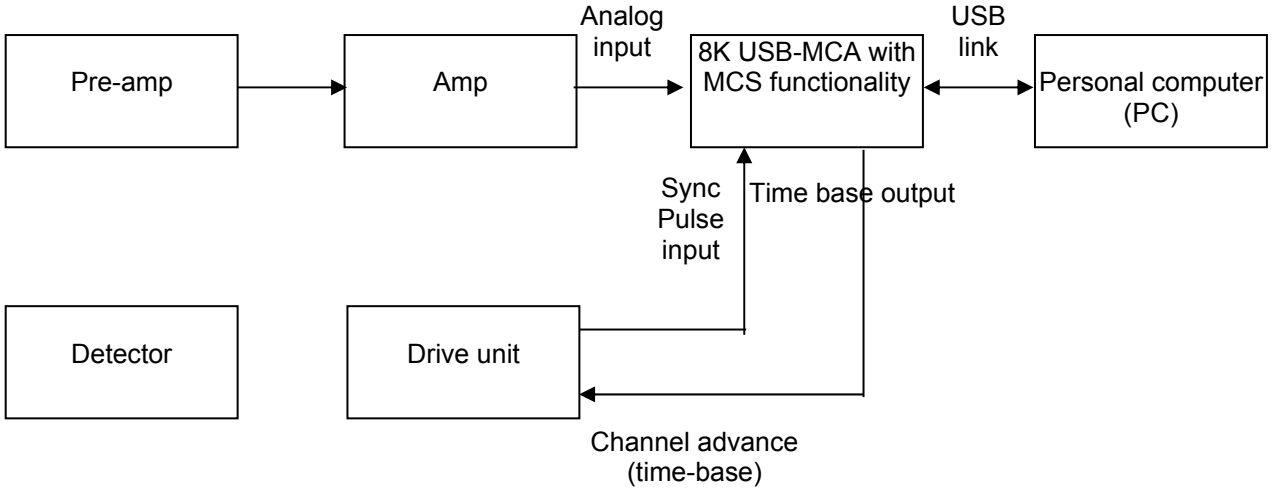
Status	ACQ Off
Mode	MCS
Date	10/12/2008
Time	11:15:48
Exp Time	1500000
Live	0
CG	1K
Dead time (%)	Dead time
File	File
Sample	Sample
LLD	5.000
ULD	6.000
Baseline	0.000
Dwell Time	98
Pass count	999999999
Stop mode	By Acq Time

The status window has following parameters :
Status : Indicates current experiment status, whether the acquisition is ON/OFF.
Mode : Indicates current mode of MCA operation (PHA/MCS).
Date : Indicates current system date of experiment
Time : Indicates current system time of experiment
Exp time : Indicates total experimental time
Live : Indicates live time during experiment (PHA only)
CG : Indicates conversion gain (ignored in case of MCS mode)
Dead time (%) : Indicates the dead time correction (PHA only)
File : Indicates the name of the file when loaded
Sample : Indicates the samples ID of the source, entered by the user
LLD : Indicates the value of LLD set in volts
ULD : Indicates the value of ULD set in volts
Baseline : Indicates the value of baseline set in volts
Dwell time : Indicates the dwell time of MCA
Pass count info : Indicates the max no of cycles of MCA operation (info only)
Stop mode : Indicates the MCA stop mode. (by Acq time / Exp time only)

Application notes

The typical applications of the MCS mode include the following :

1. Mossbauer spectroscopy
2. Other time related isotope studies



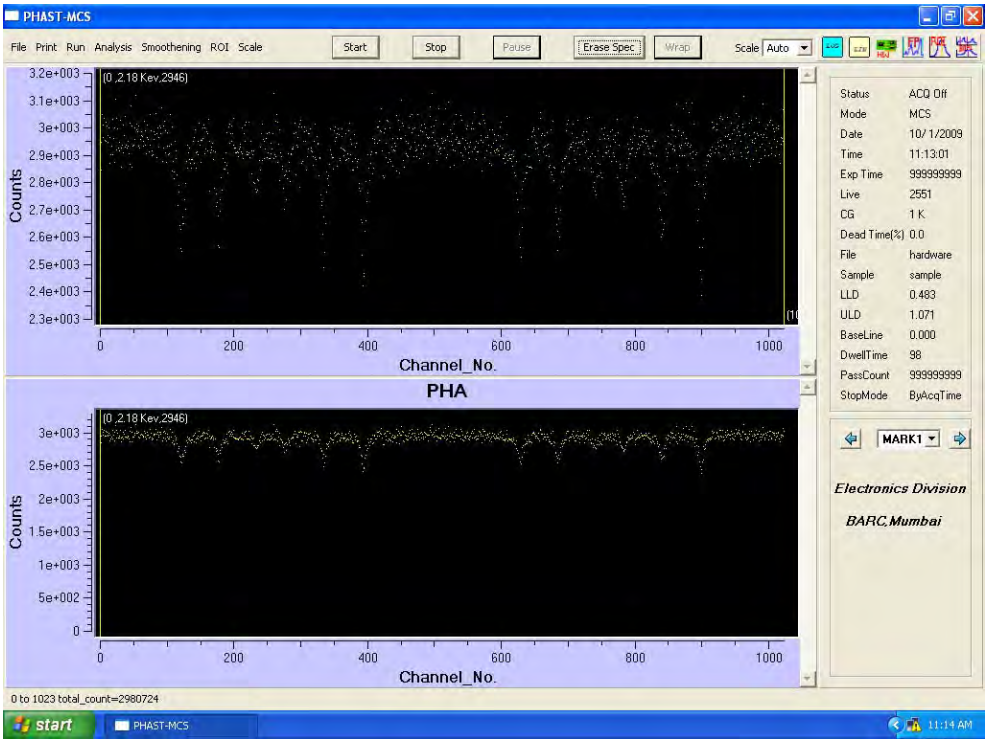
The block diagram of a typical Mossbauer spectroscopy system

A typical test experiment is carried out for mossbauer spectroscopy. Initially, the MCA is operated in the standard PHA mode with 1K resolution. The settings of the external active filter amplifier are adjusted in such a way that the peak of interest is prominently visible in the spectrum. The LLD, ULD levels are set for the peak of interest. The acquisition is then stopped. After this, the MCS mode acquisition is started with the settings given below, without disturbing the set LLD and ULD values.

Dwell time : 98 □s
Pass length (channels) : 1K (1024) channels
Acquisition mode : ADD
Channel advance (dwell pulse) : Internal
Sync pulse : External
Acquisition timer : 3600 seconds (user can set a higher value)
MCA op mode : MCS

The analog input (positive, unipolar, Gaussian shaped analog pulses with 2 ms shaping time constant) is applied from an external active filer amplifier. The other respective signals are also applied as shown in the above block diagram most of the settings are default in the application software.

The typical spectrum acquired from the mossbauer experiment is as shown below as an example :



(iv) Analysis Menu

This contains a number of highly useful analysis functions as given below.

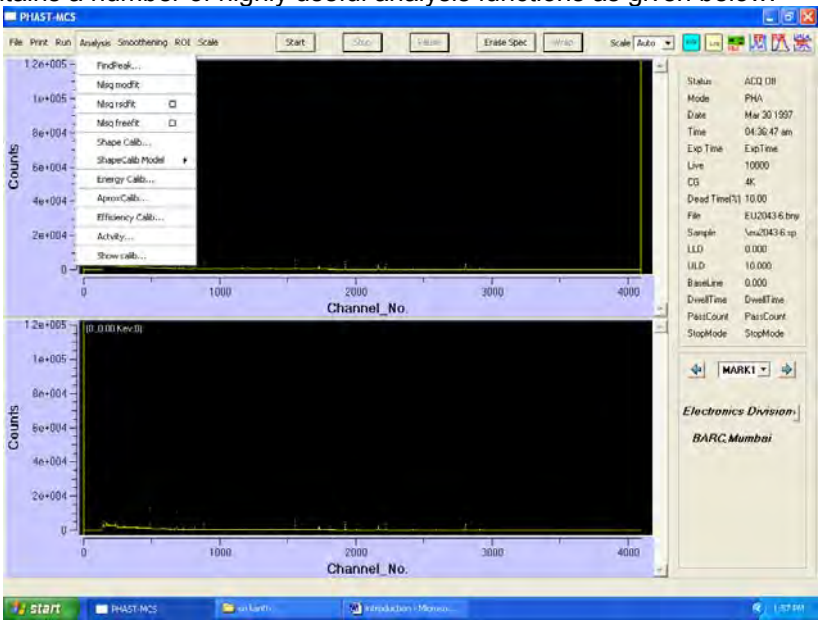


Fig: Analysis Menu Displayed

The MCA emulation part of this software provides standard MCA functions like peak finding, peak area determination, energy and efficiency calibration, etc., available in most commercial packages. The gamma analysis software can search for up to 500 peaks. This analysis software also provides an extensive gamma library and outputs a graded list of nuclides for match with gamma energy of interest in the spectrum. It also provides a weighted average of activity calculated with several energies for nuclides with multiple gamma emission energies.

At the end of any type of analysis, the results are reported in a scrolling display below the spectrum window. The scrollbar may be moved clicking on the up or down buttons on the side of the numeric results display or by clicking near the top or bottom border within the results display. Several menu buttons, appropriate for the analysis, appear along with this display.

Any of the reported peaks may be selected for further processing (e.g. as a point for energy calibration). The scrollbar is first positioned on the peak. The peak is then selected by double clicking on any of the columns when an asterisk (*) appears in the tag field. It may be deselected in the same way by double clicking on any of the columns. The spectrum display is closely coupled with the numeric results display. If the scrollbar is on a particular peak, the same peak is shown centered in the zoom spectrum display.

b) Find Peak

When this is selected, a dialog box giving the default conditions of peak search (criteria) will appear as follows.

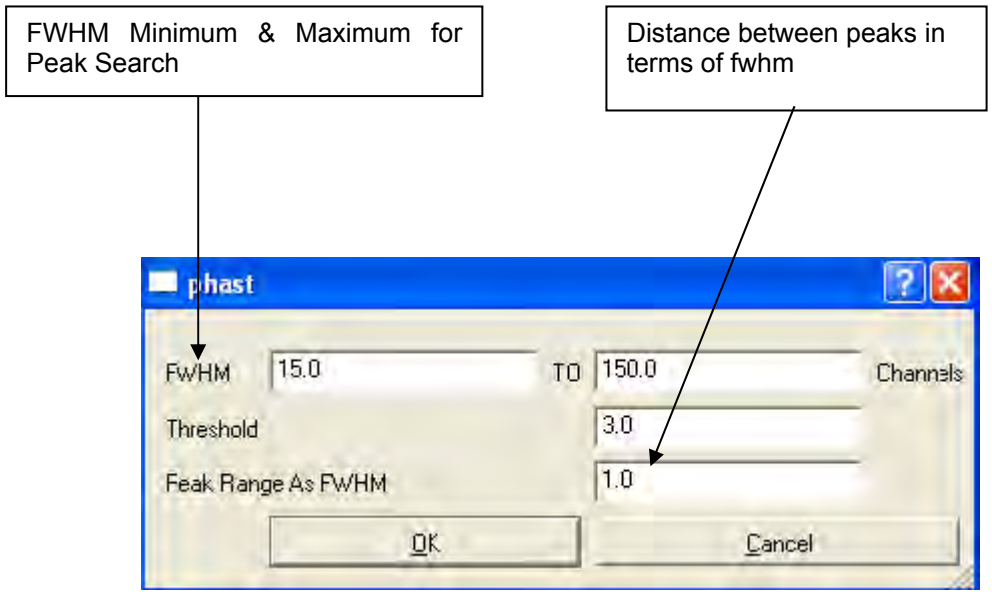


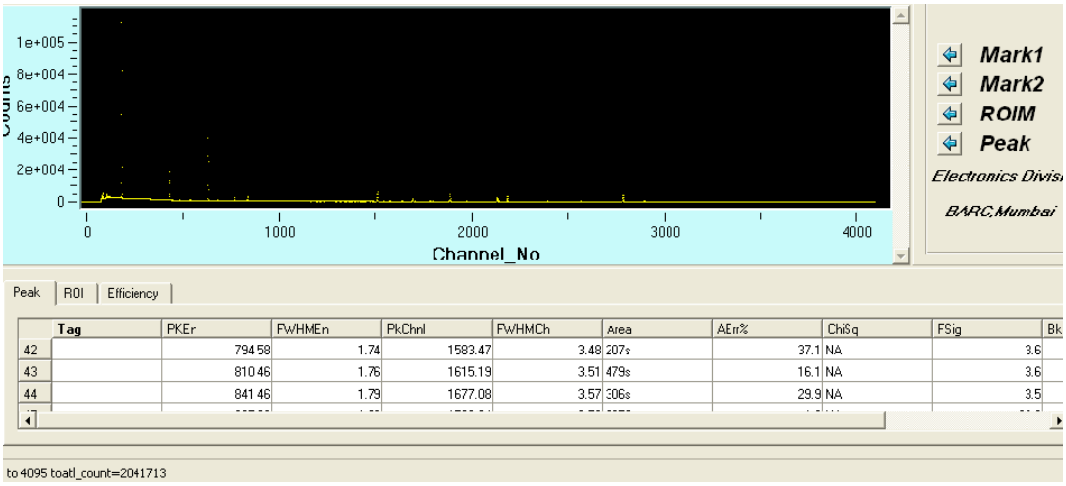
Fig: Peak Search Criteria

The default FWHM range in channels depends upon the conversion gain and is usually suitable for high-resolution gamma spectra in 8k and 4k and for NaI(Tl) in 1K. It is used in screening peaks. Peaks with FWHM below the range are marked N (narrow) and those above the range are marked W (wide). Their areas are not calculated. The default peak range shows the peak range on either side of peak in multiples of FWHM and is used for calculating single peak area by summation. The default threshold is used for accepting the peaks from the result of convolution of the spectrum with a zero-area filter function (2nd derivative of gaussian). If shape calibration is available, the FWHM calibration will be used for the filter.

If FWHM calibration is not available or is not to be used, e.g., when it is not applicable, **care should be taken in entering user's value of minimum FWHM** since this is used for the filter function. A value of 80% of actual minimum FWHM is recommended. If this is kept too low then small peaks will be missed. An increased peak range may be entered if there is considerable tailing. It may be decreased to avoid large multiplet peak groups. The optimum value is case specific.

At the end of peak search the results are displayed as given above. The vertical and horizontal scrolls are to be used for scanning of the peak report (table). The columns are standard parameters available from packages and need no explanation.

In the below example, the first member of a group of multiplet peaks is tagged **M** while the others are tagged as **m.** Energy and FWHM are given in both channel units and energy units (if energy calibration is available).



	Tag	PKEr	FWHMEn	PkChnl	FWHMCh	Area	AEr%	ChiSq	FSig	Bk
42		794 58	1.74	1583.47	3.48	207s	37.1	NA	3.6	
43		810 46	1.76	1615.19	3.51	479s	16.1	NA	3.6	
44		841 46	1.79	1677.08	3.57	306s	29.9	NA	3.5	

Fig: Peak Report

Areas are calculated by summation for singlet peaks and by gaussian fitting for multiplet peaks and are marked **s** and **g** respectively. In case of summation, area error is calculated from the peak and background count variances. In case of gaussian fitting, area error is calculated from the error matrix and chi-square. Since the area and errors are calculated by different methods for singlets and multiplets, they should be used with discretion, especially when area comparison is involved. The quantity '**Fsig**' gives the significance, in units of standard deviation, of the convolution of the spectrum and the peak search filter at the peak channel. The peak report can be printed (refer to print menu) and saved on to file (refer to file menu).

Nonlinear least square fit with peak model

Three fitting options are available under this category are as follows:

b) Nlsq modfit : for fitting with a peak model with shape calibration available

c) Nlsq rsdfit : for fitting as above along with automatic insertion of peaks at locations of significant residue.

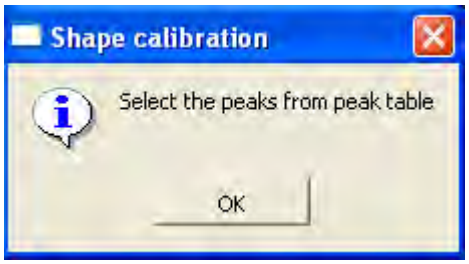
d) Nlsq freefit : for fitting with a model without shape calibration. The shape is determined from the spectrum under analysis.

A proper peak shape model should first be selected and calibrated with a spectrum containing peaks with good counts. This shape calibration is available in subsequent sessions. Alternatively the existing calibration may be used or a stored calibration may be loaded. The calibration is applicable only if the calibration spectrum and unknown spectra to be fitted are acquired with the same spectrometer settings at comparable count rates. Sometimes very good fit may be obtained if prior shape calibration is performed with the spectrum under analysis itself, provided it contains several well-spaced strong single peaks.

e) Shape Calibration :

Shape should be calibrated with a spectrum containing several single peaks with good counts covering the entire span of energies of interest. Calibration is started by a click on the Analysis -> Shape Calib. menu item. The process begins by finding peaks without using any previous FWHM calibration. The default peak search conditions are to be confirmed or changed as in Find Peak. The peaks are found and the results are displayed as in Find Peak.

Strong single peaks are now selected (minimum 3) by the user and then **Selection Done** is pressed. The FWHM polynomial and its plot are now displayed. Outlying points are rejected from this polynomial fit and displayed in a different colour.



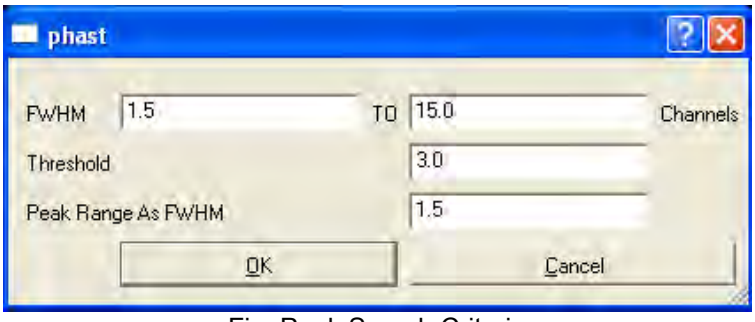
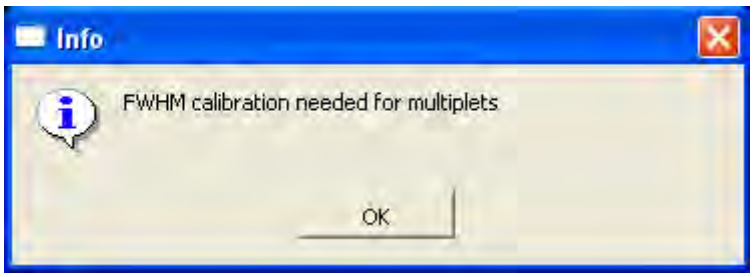


Fig: Peak Search Criteria



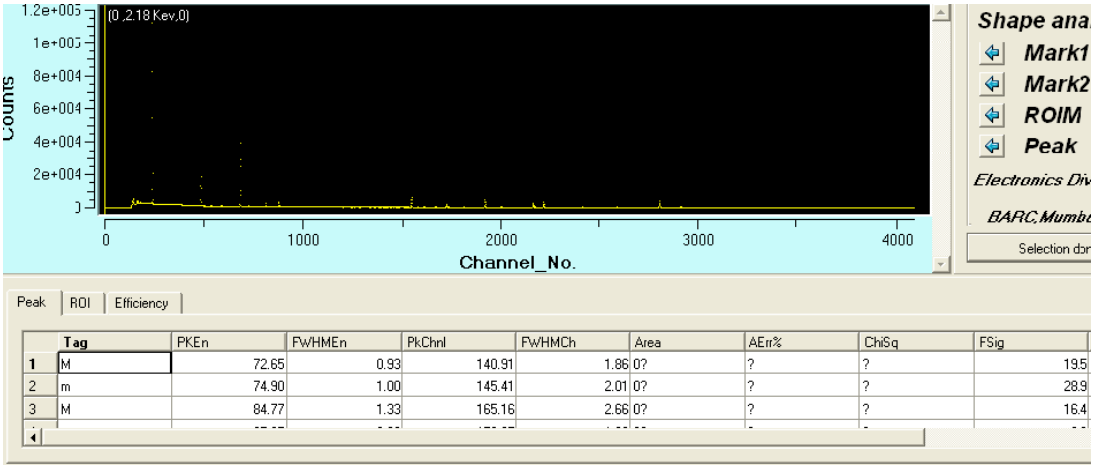
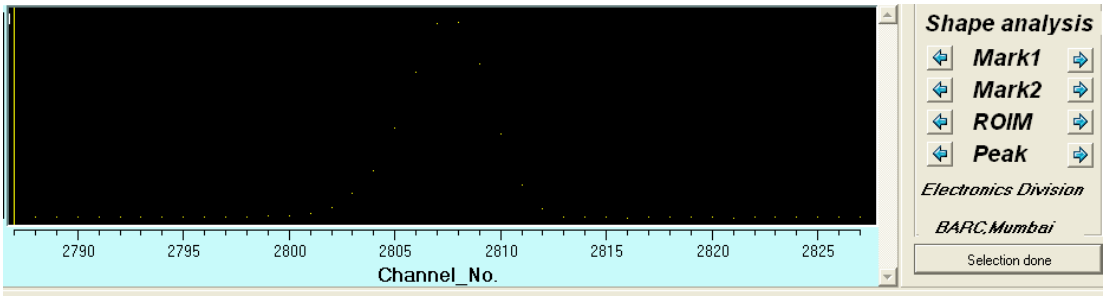


Fig: to select peaks from the peak table



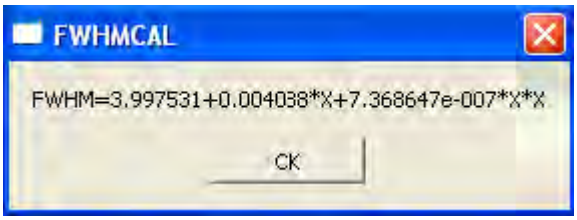


Fig: FWHM Calibration equation

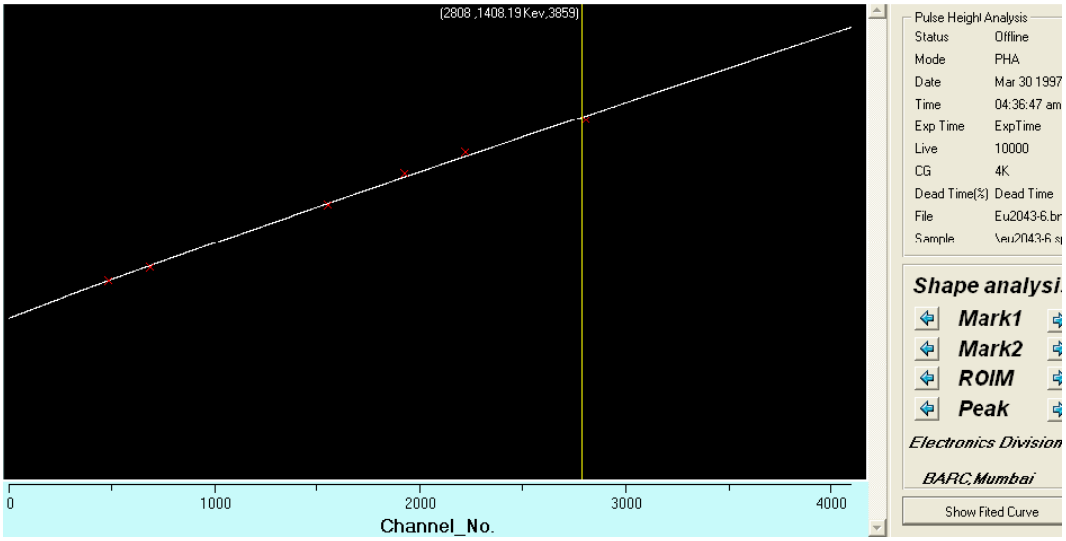


Fig: FWHM Calibration Graph

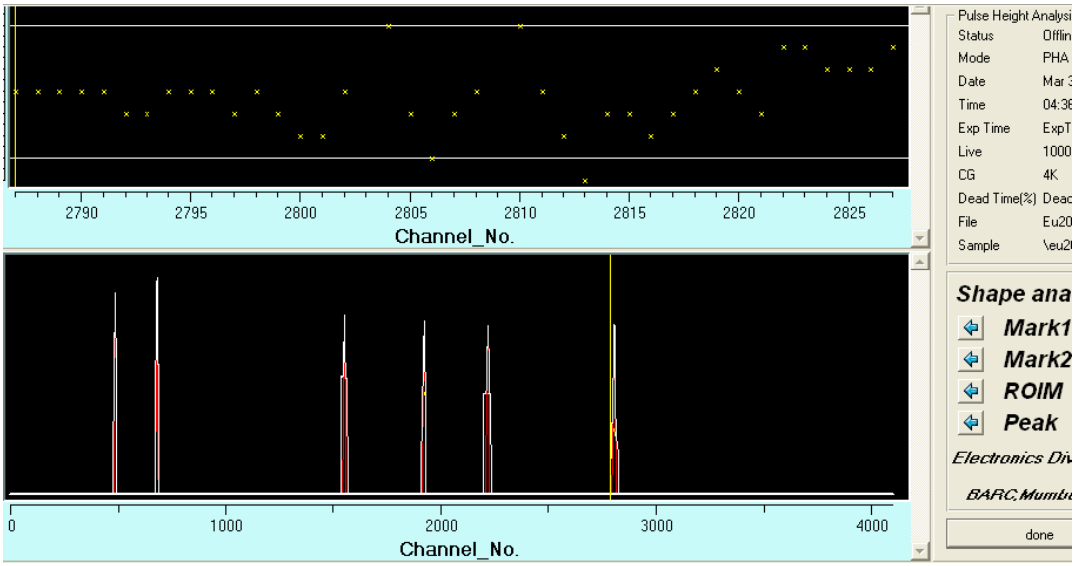


Fig: Shape Calibration Graph

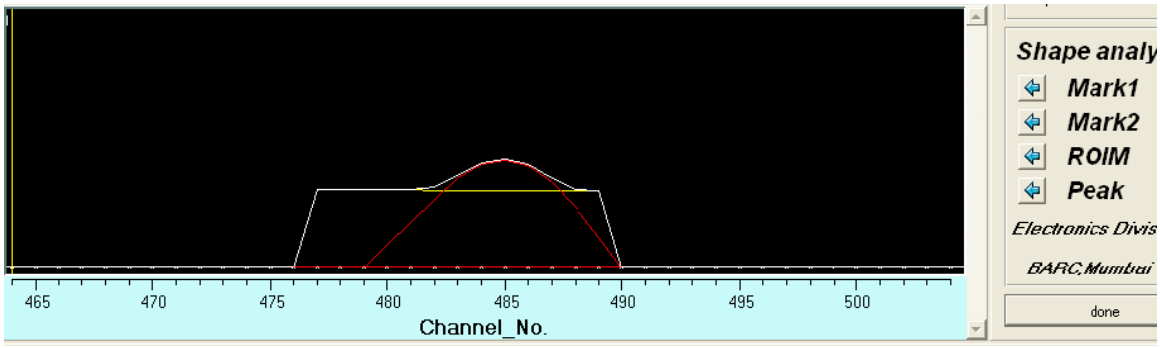
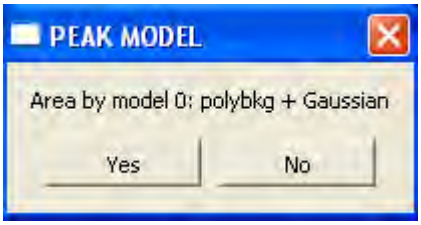


Fig: Shape Calibration fitting curve

Shape Calibration Model:

The current Peak Model is displayed on the dialog line as follows:

Area by model 0: polybkg + Gaussian



By clicking on Peak model 0…5 one of the following models may be selected:

Model0: polybkg + Gaussian
Model1: polybkg + Gaussian + low exptail
Model2: polybkg + Gaussian + low exptail + high exptail
Model3: polybkg + Gaussian + low exptail + high exptail + step
Model4: polybkg + Gaussian + low exptail + step
Model5: polybkg + Gaussian + step

f) Energy Calibration:
For energy calibration, one may enter the three calibration constants directly. The peak locations found by **Find Peak** may also be used for energy calibration. The user should be familiar with the peak locations and energies in the calibration spectrum. The user should select the energy calibration menu item by clicking on the analysis menu and begin energy calibration by clicking on the **Energy calib** item when the following dialog box appears enquiring whether one wants to enter the coefficients for energy calibration

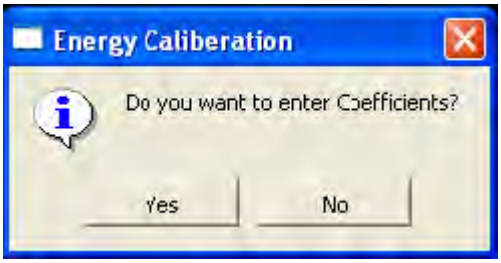


Fig: Energy Calibration Method selection

If ‘yes’ is clicked, the user will be prompted to enter the three coefficients of the second-degree calibration polynomial as given below. After entering the coefficients, click ‘ok’ button leading to a display of the energy calibration curve.

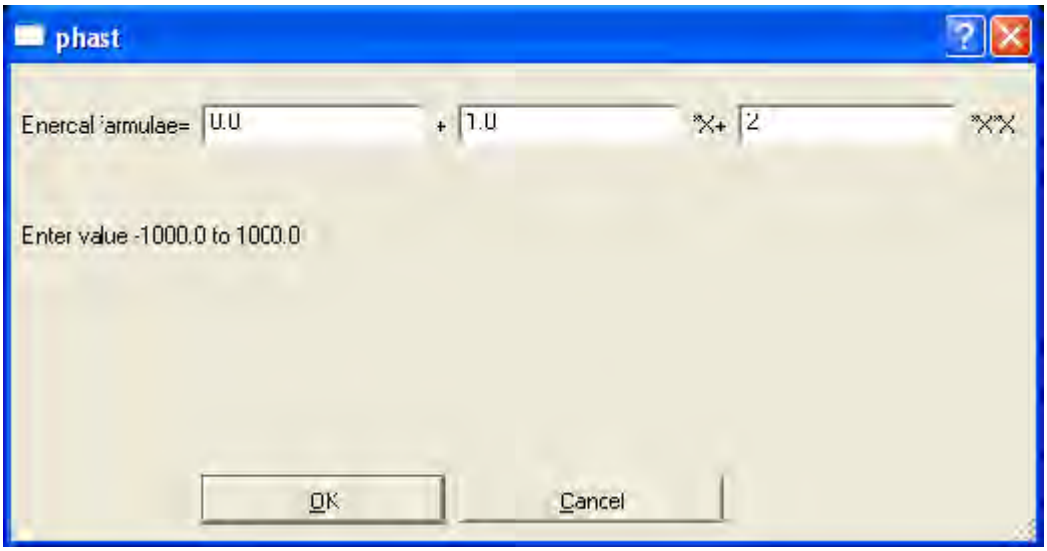
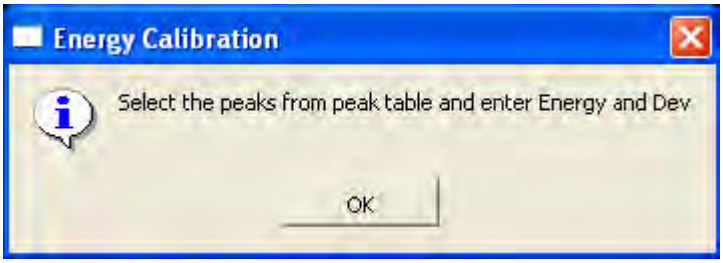


Fig: Energy calibration – user constants entry form

If 'no' is entered, a peak report appears. The user should now select energy peaks one by one by double clicking on the row of entry to be selected. The selected peak is marked by a '*' and a dialog box appears where the energy and the



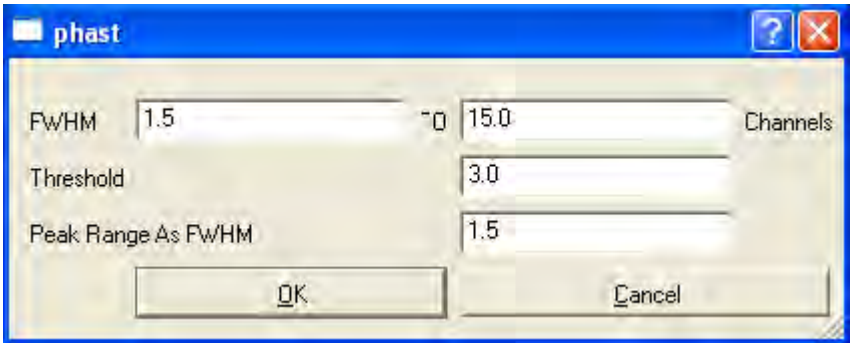


Fig: Peak Search Criteria

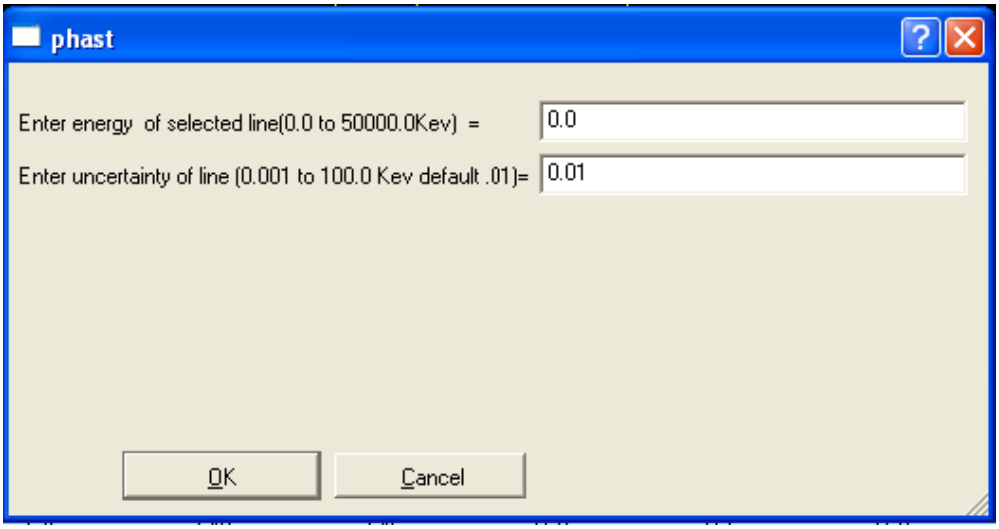


Fig: Energy Calibration by peak selection

Uncertainties (use default if not available) are to be entered by the user. The peak entered should have good cps. . At each stage, the peak will appear in the zoom display. Once the desired number of peaks (minimum 3) are entered, the 'done' button has to be pressed to complete the calibration process when the calibration constants (calibration polynomial) are displayed in a box as given below in a dialog box. On pressing the 'ok' button the energy calibration curve will be displayed as given in the picture below

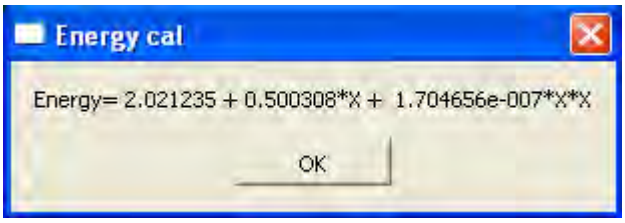


Fig: Energy Calibration Second order equation

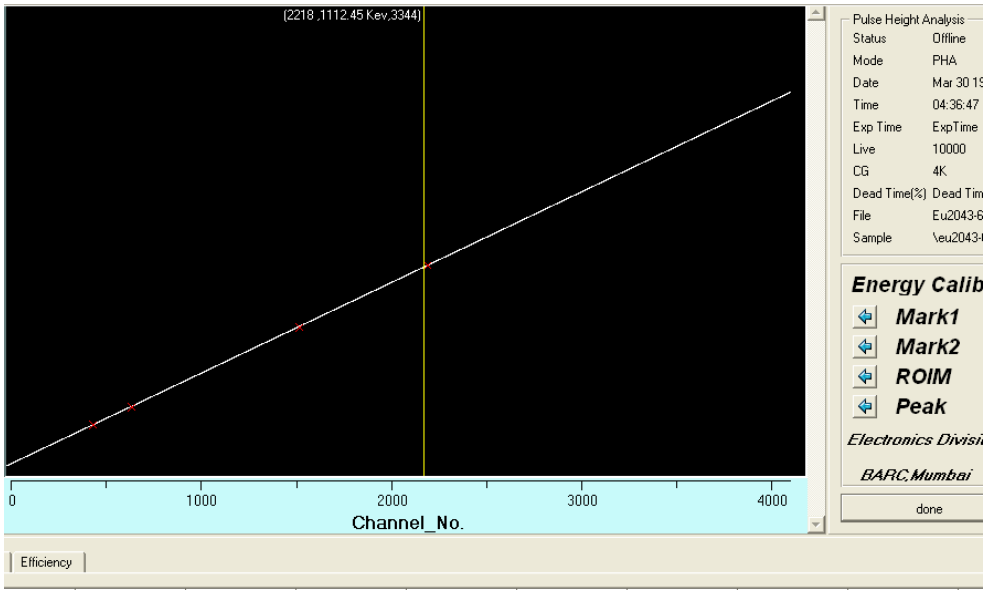


Fig: Energy Calibration graph

At the end of the energy calibration process, the 'done' button seen on the right side (lower) of the screen has to be clicked for normal restoration of the software.

g) Approximate Calibration:
The peak locations found by Find Peak or one of the fitting procedures (preferred) may be used for energy calibration. The user should be familiar with the peak locations and energies in the calibration spectrum.
Sometimes it is helpful to perform a preliminary approximate energy calibration. In the Approx Calibration channels are selected one at a time by the spectrum cursor and the Enter Kev button below the spectrum window enters corresponding energies. The calibration process is terminated by the Over button. This procedure permits energy calibration with one or more points.

h) Efficiency Calibration:
This option is for calibrating the efficiency of the spectrometer. When the dps at several energies and the corresponding cps are available the program calculates the efficiency as a log power polynomial.
In order to get calibration data, the spectrum of a known source is acquired with a source detector arrangement of known geometric efficiency. Alternatively the geometric efficiency may be provided in a relative manner in all experiments. The spectrum is first analyzed with **Find Peak** or with one of the nonlinear least square fit (currently not enabled) procedures to find the peak areas. The **Efficiency calib** menu item is then pressed. The user is first prompted to give the Energy match tolerance/FWHM ratio with the following dialog box. The energy match tolerance/FWHM ratio (used as a search criteria for the library) has to be entered against 'Val' or the default value can be used.

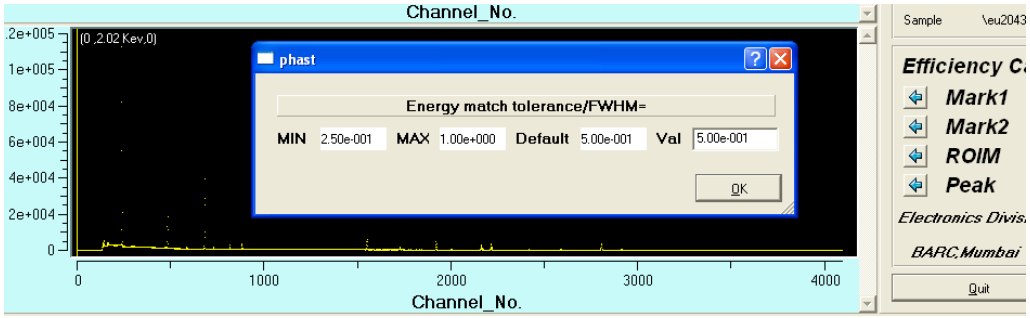
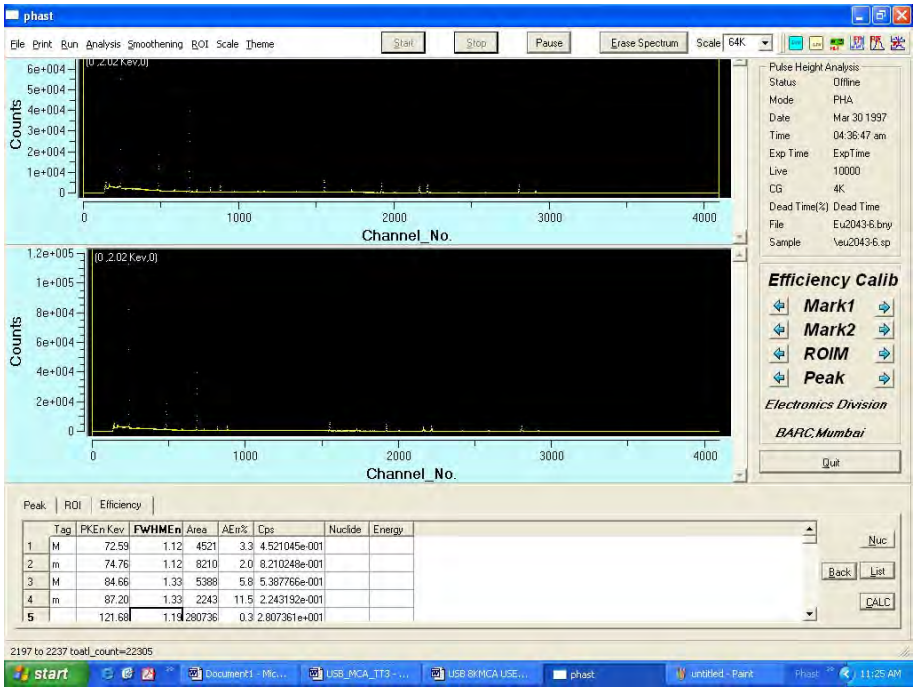


Fig: Energy match tolerance/FWHM dialog box

On pressing the OK button, the following screen appears. The peak energies, corresponding CPS values and a few other parameters as shown below are displayed



The section of the display (lower right part) is displayed below to show the various buttons.

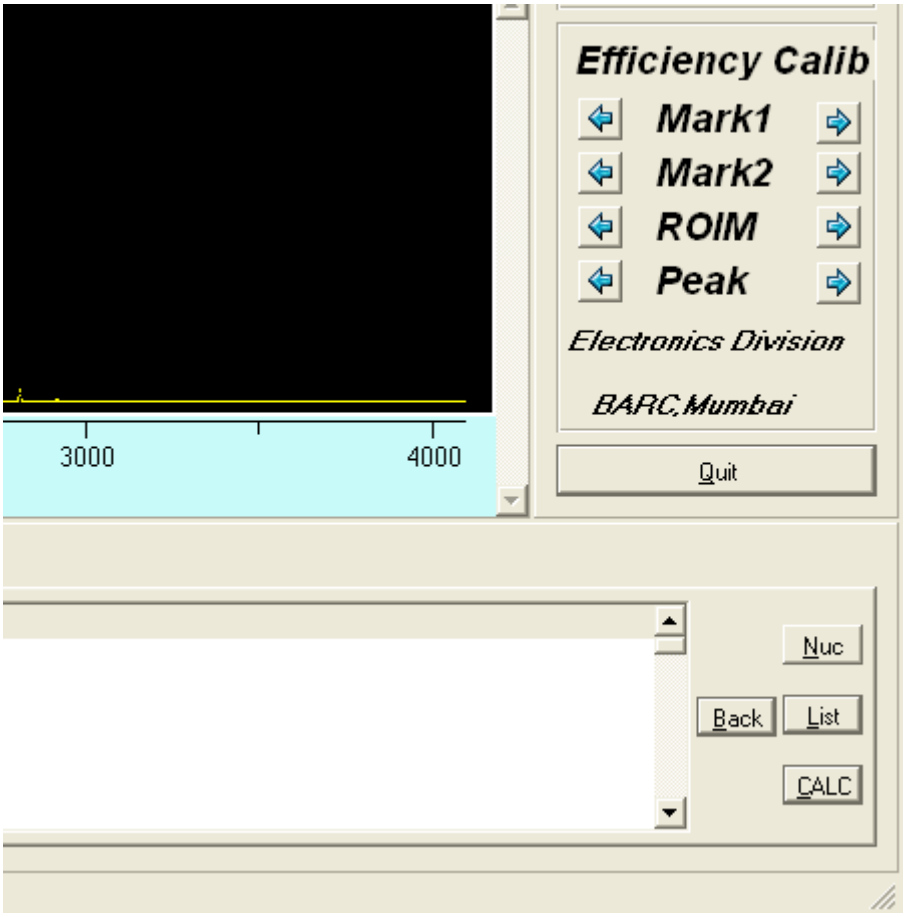


Fig: Various Buttons for Efficiency calibration

One of the calibration energies has to be selected by the mouse. On clicking on the Nuc button, the user is prompted to provide the relative geometric efficiency. The default value of 1 may be used. Care has to be taken to ensure that the relative geometric efficiency, which has to be used in a subsequent activity calculation, should have the same value.

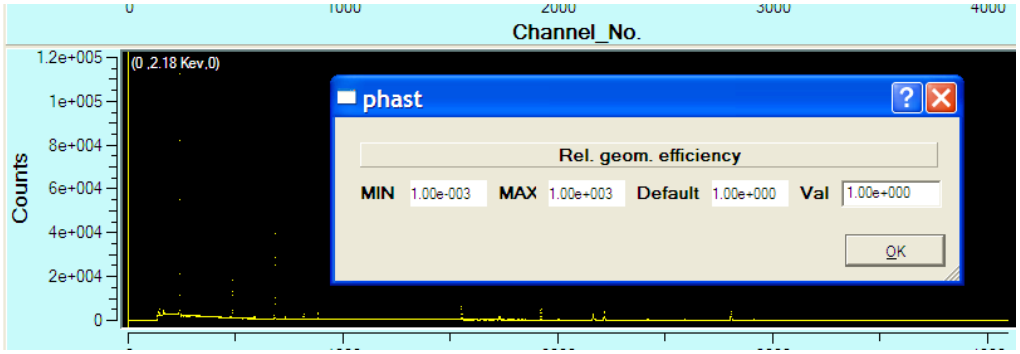


Fig: Select Relative Geometric Efficiency

On closing the dialog box, the following display of decay data of the nuclide with the closest energy match is displayed (the left side table shows the library data).

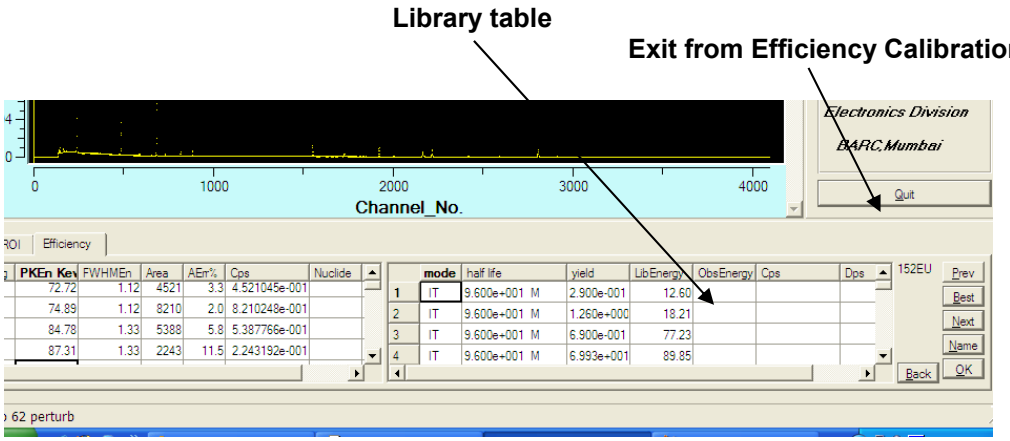


Fig: List of Energies for the Nuclide as per library

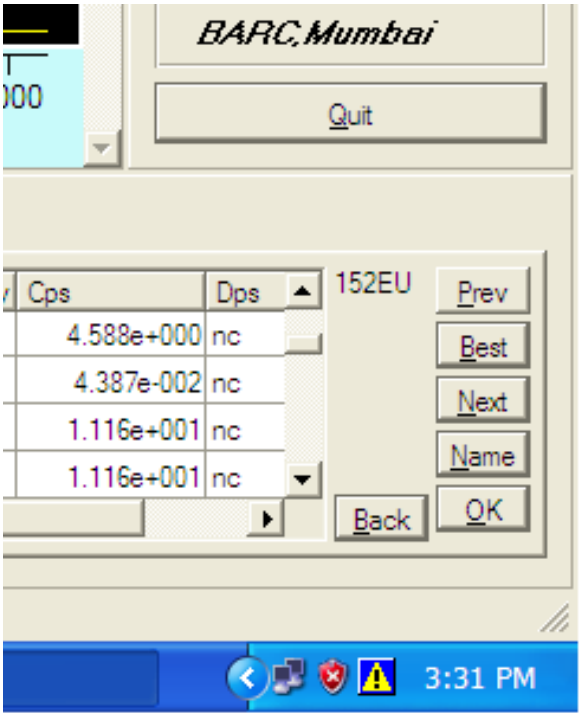


Fig: Navigation Buttons

The user may now navigate among the nuclides by the **Prev, Best and Next** buttons to get the nuclides in an ascending order of energy mismatch with the reference energy selected. Since in this case the calibration nuclide is known, the user should get the same nuclide by navigating or by directly entering the nuclide with the **Name** button.

The user then selects the calibration energies showing large experimental cps by double clicking on the library energies necessary to span the energy range of interest as in the figure below showing some of the selected energies marked by '*'.

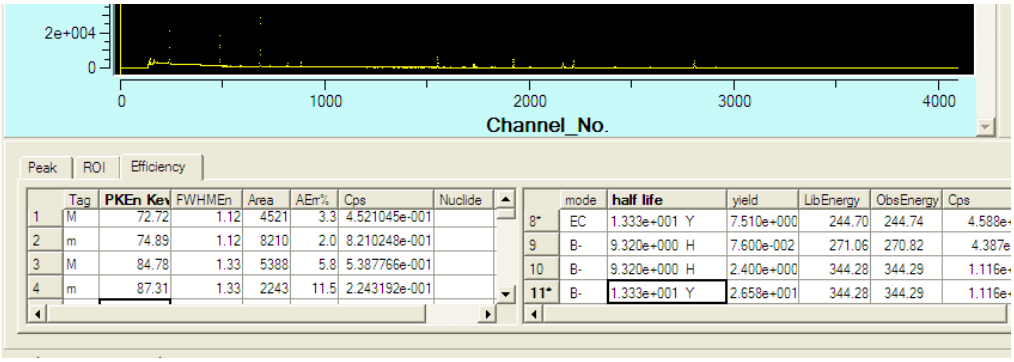


Fig. Selection of calibration energies from library and observed data

Note that where identical energies with different half-lives are available, the half-life of the entered energy must be same as the earlier selected half-lives. After all energies are selected, the user presses **OK.**

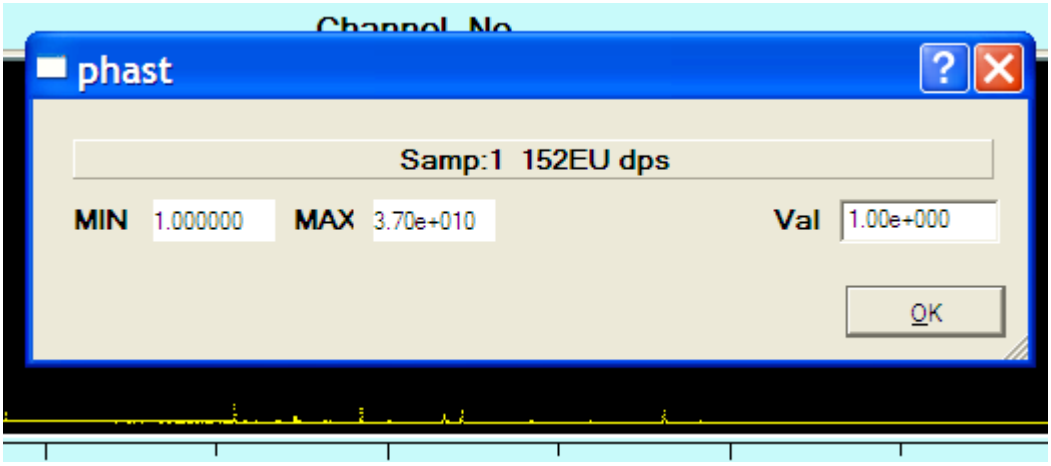


Fig: DPS entry Dialog box

The user is now prompted to provide the known dps of the source. The user then presses the **Calc** button. Now the program prompts to get the applicable energy range for the calibration after which the calibration polynomial and calibration curve are displayed.

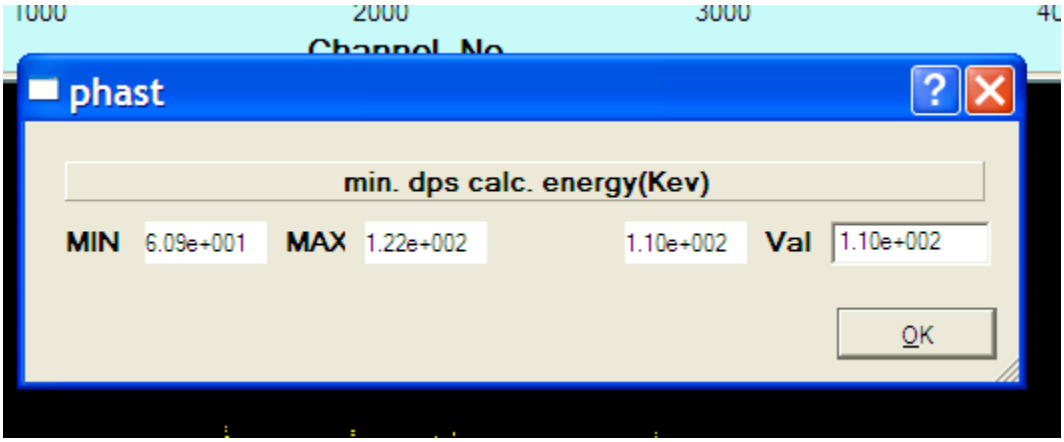


Fig: Lower Limit of Energy for Efficiency calibration

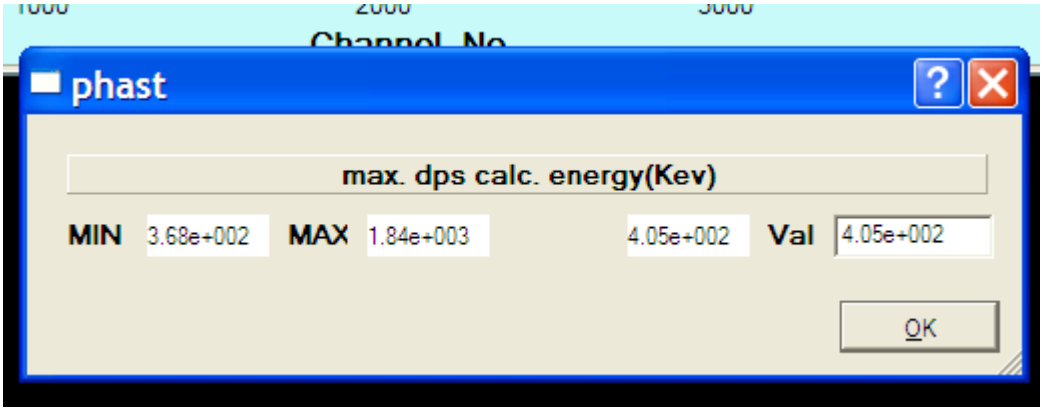


Fig: Upper Limit of Energy for Efficiency calibration

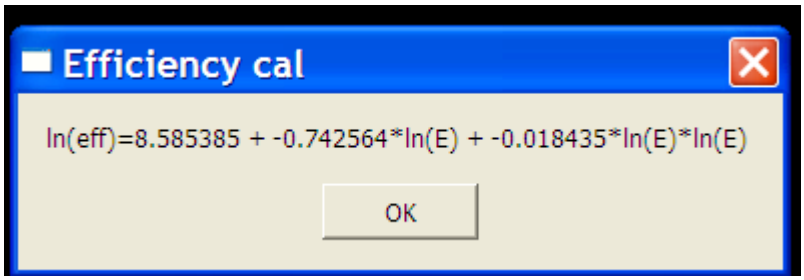


Fig: Efficiency calibration formula with computed constants

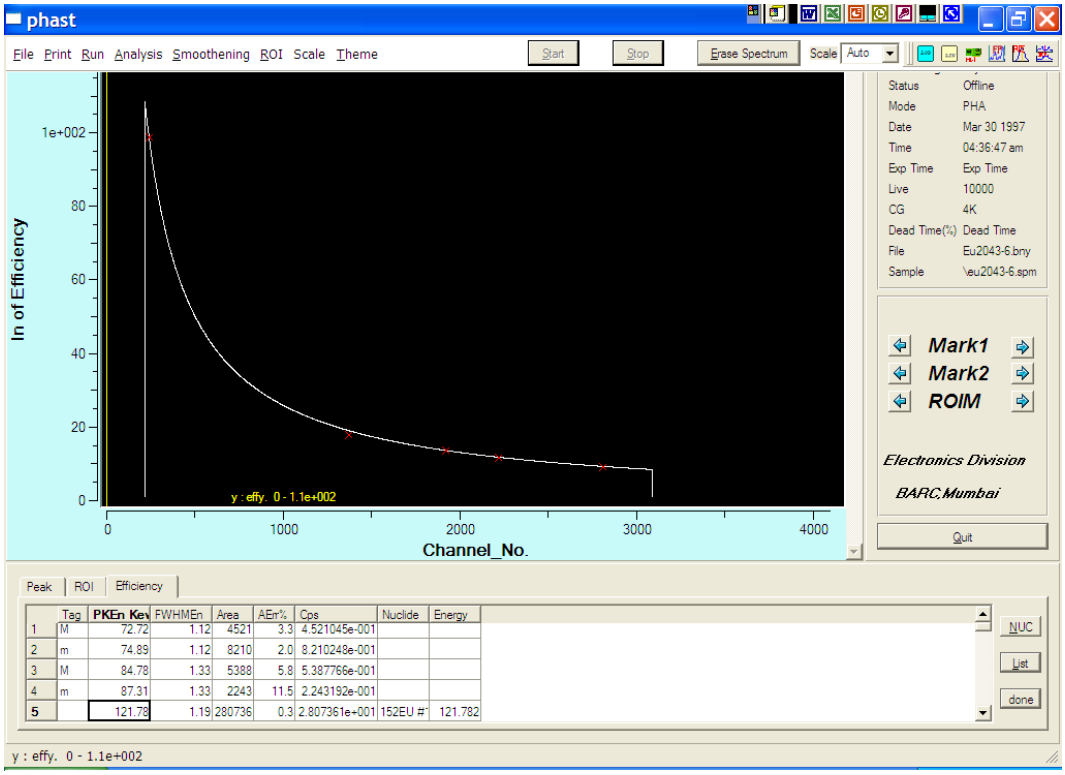


Fig: Efficiency Calibration Graph

This calibration will remain effective for any subsequent activity determination until overwritten by another calibration. If the user exits without pressing the **Calc** button, the program will prompt to know

whether data from another source will be appended. This is useful since one source may not have energies suitably spanning the energy range of interest. The user may thus provide data from several other acquired spectra. It should be noted that separate efficiency calibration curves are needed on either side of 200KeV for HPGe detector.

The user has to save the spectrum again (binary) so that the recently calculated calibration constants are saved.

The user has to come out of the calibration mode by clicking on the 'quit' button.

i) Activity :
This option is for calculating the activity of unknown samples if the efficiency calibration is available. On selecting this menu item from the analysis menu, the user is prompted for the Energy match tolerance/FWHM ratio.

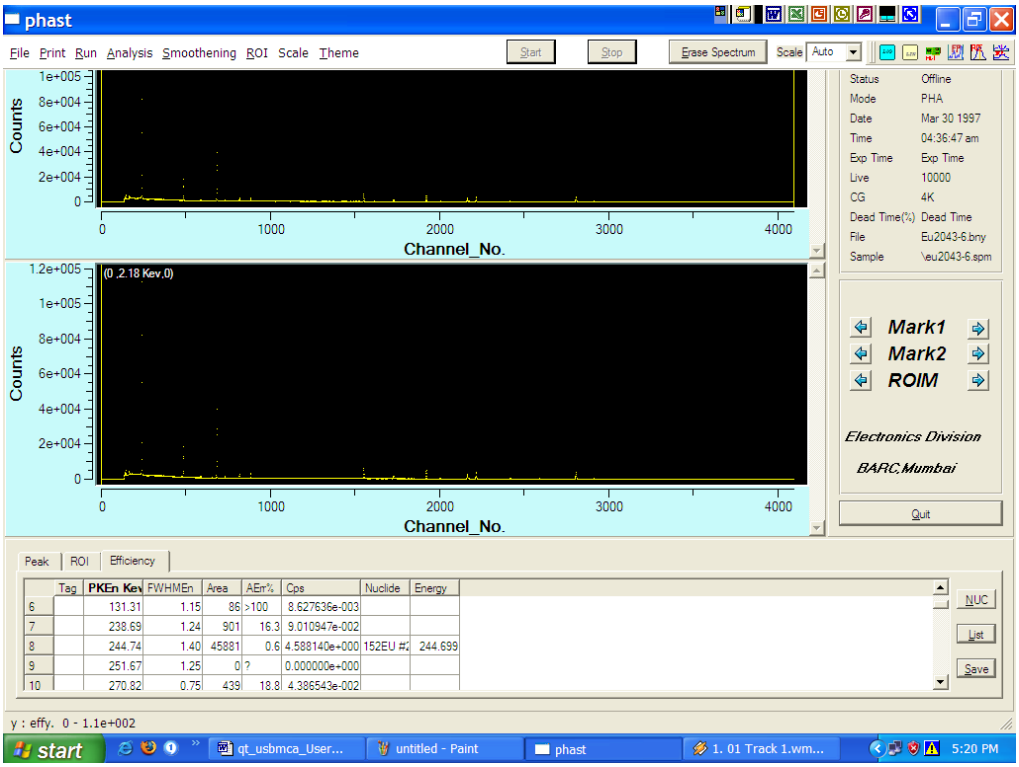


Fig: Activity Calculation

The user is then presented with a display very similar to nuclide navigation display as for efficiency calibration and is prompted to provide the relative geometric efficiency. The user enters the relative geometric efficiency at the prompt. The procedure for nuclide navigation is the same as described for efficiency calibration before. After the nuclide is selected, the user selects the strongest observed line (or several comparably strong lines) from the library and observed data display. Now the user presses the **OK** button to get the weighted average of dps with error.

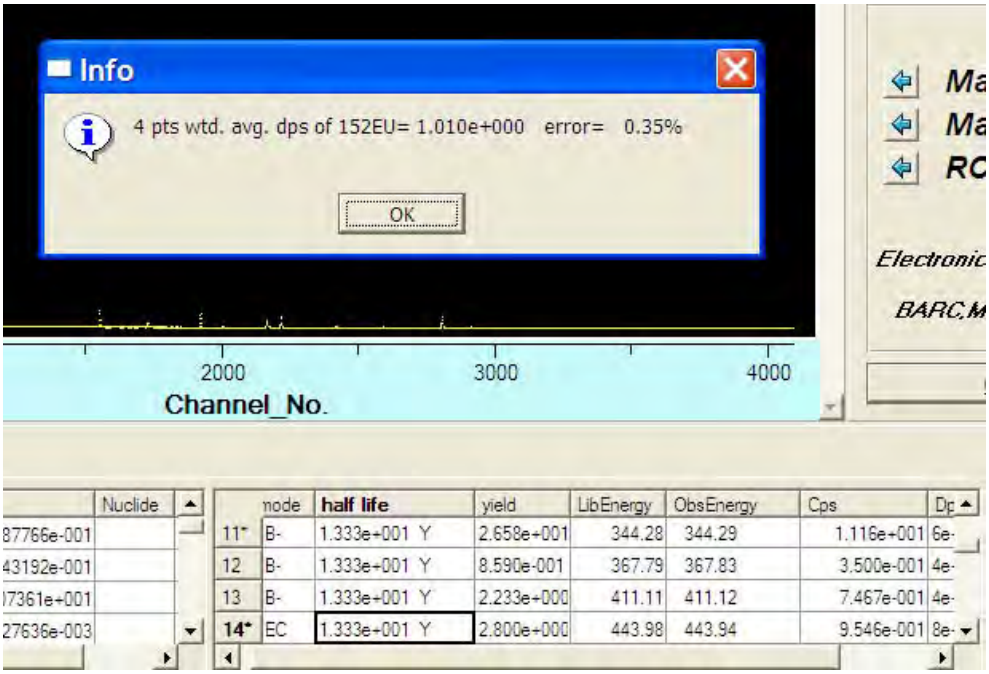


Fig: Weighted average of dps with error

In this, it is assumed that the uncertainties of the efficiency calibration coefficients are relatively small and may be neglected. The user now exits to the nuclide navigation display. Another energy may now be selected to find the activity of another component of the sample. The results are stored in a file (with extension .act) by the **Save** button.

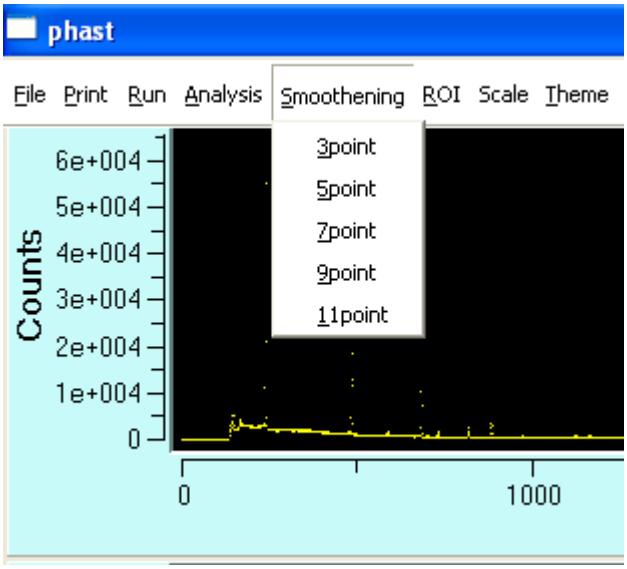
PHAST PEAK REPORT

File Eu2043-6.bny
Sample \eu2043-6.spm
Date Mar 30 1997
Time 04:36:47 am
Live 10000
CG 4K
Energy Calibration Parameters 2.02123 + 0.500308 * X + 1.70466e-007 * X * X

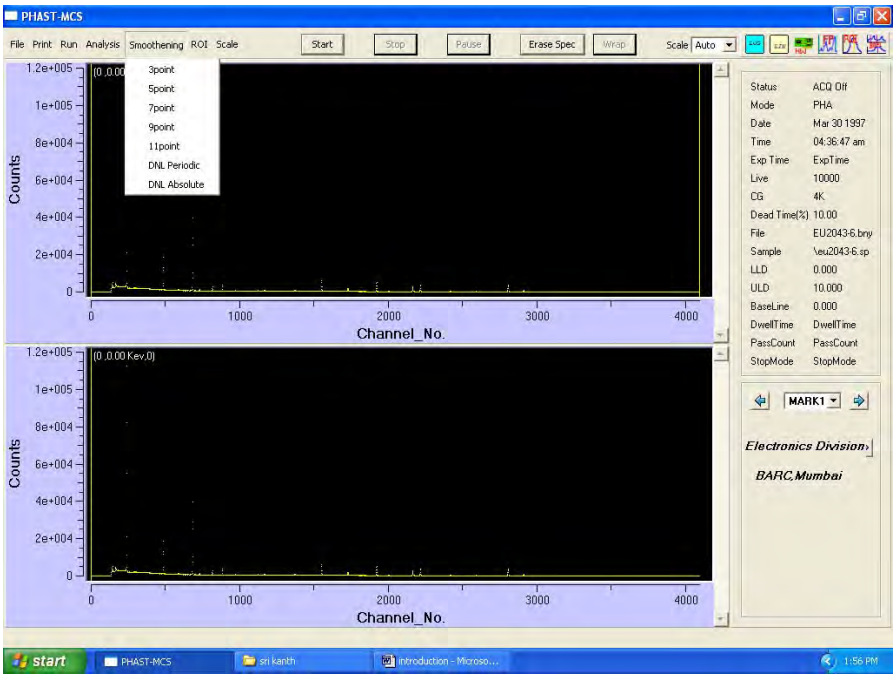
Tag	PKEn	FWHMEn	PkChnl	FWHMCh	Area	FSig	Backgnd	CPS
M	72.59	1.12	141.05	2.24	4521g	19.8	1.605	0.452104
m	74.76	1.12	145.39	2.24	8210g	16.0	1.680	0.821025
M	84.66	1.33	165.17	2.66	5388g	8.2	2.308	0.538777
m	87.20	1.33	170.24	2.66	2243g	7.4	2.124	0.224319
	121.68	1.19	239.15	2.38	280736s	147.2	2.597	28.0736
	131.21	1.15	258.20	2.29	86s	3.1	1.605	0.00862
	238.64	1.24	472.87	2.48	901s	4.6	1.418	0.0901
	244.69	1.40	484.96	2.80	45881s	58.6	1.010	4.58814

j) Show Calibration:

The show Calibration button is used to see the calibration equation of the FWHM, Energy Calibration and Efficiency Calibration



(e) Smoothening:



Smoothes the spectrum with Savitzky-Golay algorithm. The number of points for smoothing may be chosen as 3,5,7 or 11.

(f) ROI :

The Region of interest (ROI) can be selected by setting the two cursors in the upper window.

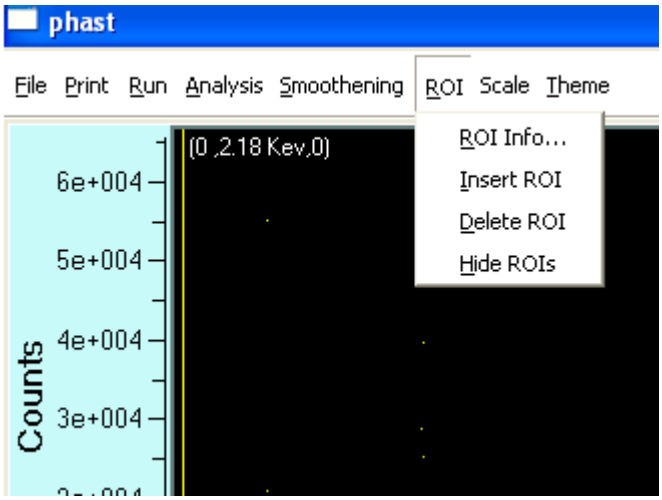


Fig: ROI Menu

i) ROI Info:

This gives the total ROI information. The ROI report consists of number of the peaks in the ROI, Peak, FWHM, TM/HM, FM/HM, Gross counts and Net counts. If in the selected ROI there is more than one peak then in the ROI information there will be number of peaks, Gross counts and Net counts.

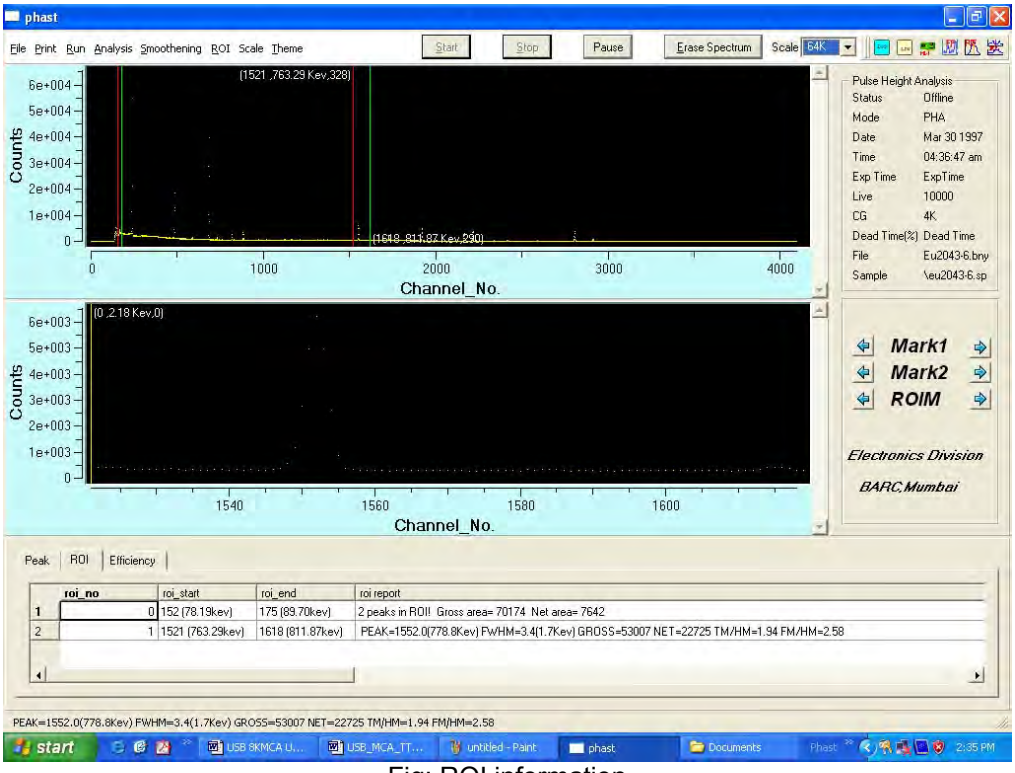


Fig: ROI information

The ROI can be spanned by clicking on the ROIM buttons. After selecting a region of interest, select the ROI menu and press ROI information to get the ROI information.

ii) Insert ROI:

The two cursors in the upper window can be moved for selecting the peak and then press Insert ROI. Now the information for that peak is displayed. The table can be saved on to a file (refer to file menu). This will be a text file with extension '.roi'.

iii) Delete ROI:
The Delete ROI is used to delete ROI already inserted into the table.

Fig: to delete ROI

If we enter the value in the box, which is appearing above that ROI value, is deleted.

iv) Hide ROI:
When we press this button the ROI's in the upper window will hide and again if we erase and start the acquisition and if we press ROI information the ROI's, which are, hide will appear back so that the data in that ROI can be viewed.

(g) Scale:
This can be used for seeing the x scale of the display in either energy or channel numbers.

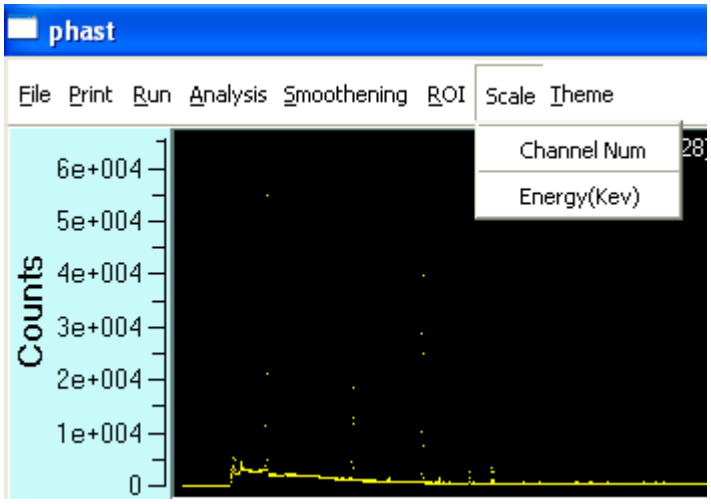


Fig: Scale Menu

APPENDIX – I

HOW TO OPERATE MCA IN 1K MODE

MCA based NaI Scintillation detector Gamma Ray Spectroscopy system (1k mode)

- For NaI Spectroscopy work MCA is operated in 1k mode as 4k or 8k resolution is undesired.
- The following block diagram (Fig: page 48) gives the interconnection details for the MCA based Gamma Ray Spectroscopy system using Scintillation detector.

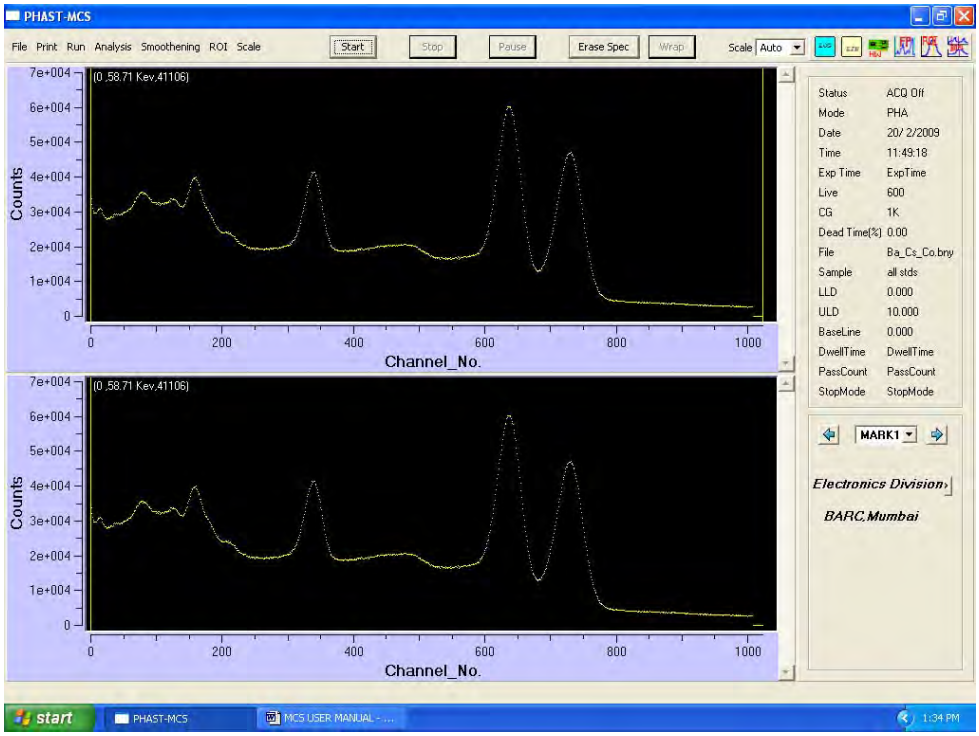
  From the block diagram given in fig one can see the interconnection details of the system
- SCA (Single Channel Analyzer) and CT (Counter Timer) are not required if one is using MCA. In case one wants to have a stand-alone single channel analyzer as a stand alone in the absence of MCA then these two modules are also required.
- To make measurements configure the system for 1k channel MCA system one can observe the following steps.

  - Connect the output of HV unit to HV Socket of preamplifier i.e.; for applying HV to the detector.
  - Apply 12V by using 5pin I/O connector for biasing of the preamplifier, which is connected close to the detector from rare side of bin circular I/O cable to LV socket. The output of the preamplifier is connected as input to the amplifier.
  - The output of the amplifier is given as input to the MCA card (Typical settings of the amplifier Attenuator 2, Gain 0.3, Time constant 1microsec, Polarity Positive, Int In).
  - Now switch on the PC, GRS. Set the operating voltage of the detector by slowly varying the HV unit knob.
  - Keep the setup idle for 10 to 15 minutes for warm-up.
  - Now place the source (Gamma) on the top of the detector. In the PC open the phast software and in the “Set Parameters” select the Exp time and Conversion Gain (1K).
  - Now press “Start” to start the acquisition. Keep the amplifier settings so that the 137Cs peak should come at 331-channel number by adjusting the fine gain.
  - After getting the spectrum acquired save the spectrum and follow the analysis as per the instruction manual.

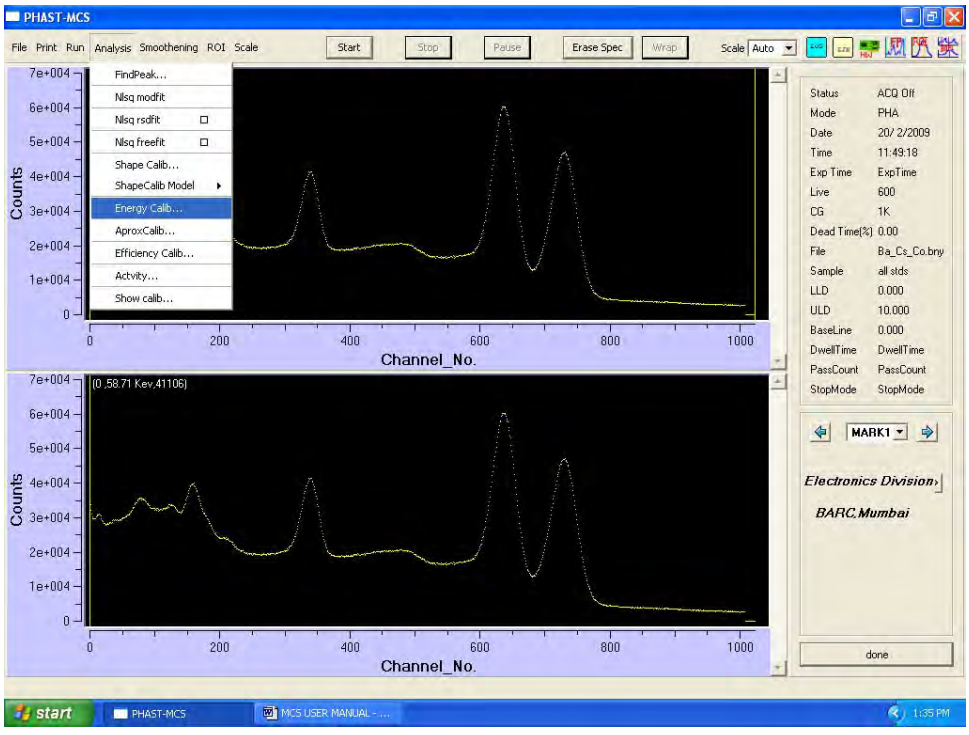
APPENDIX – II

PROCEDURE FOR ENERGY CALIBRATION

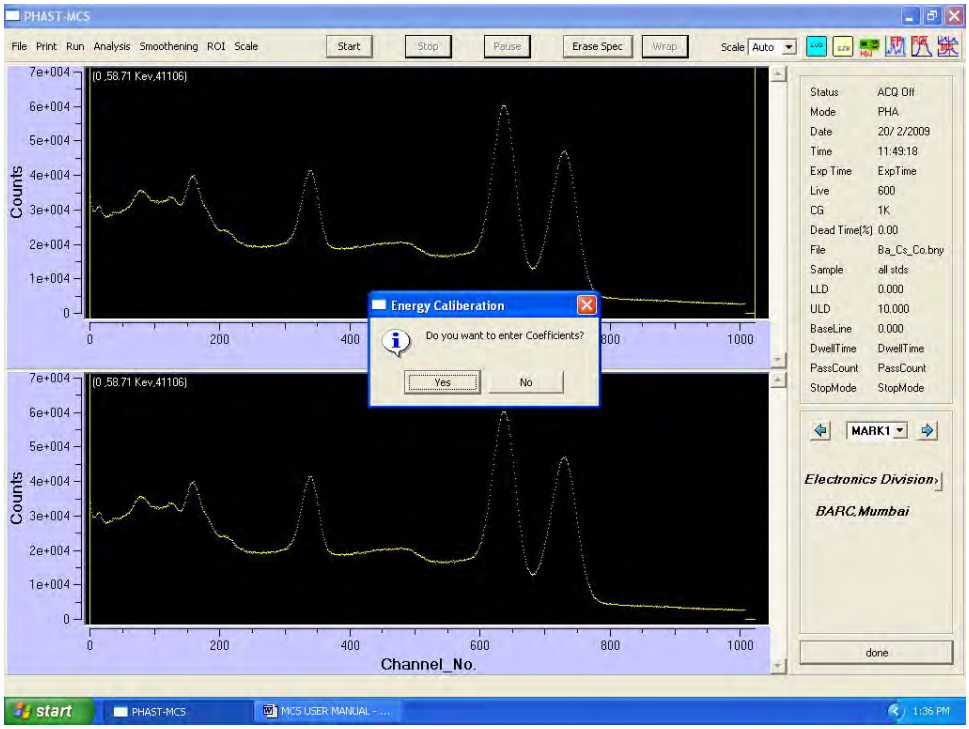
First acquire the spectrum of standard radioactive sources for obtaining energy calibration, efficiency calibration and activity.



The above figure shows the spectrum of Ba-133, Cs-137 and Co60 standards.

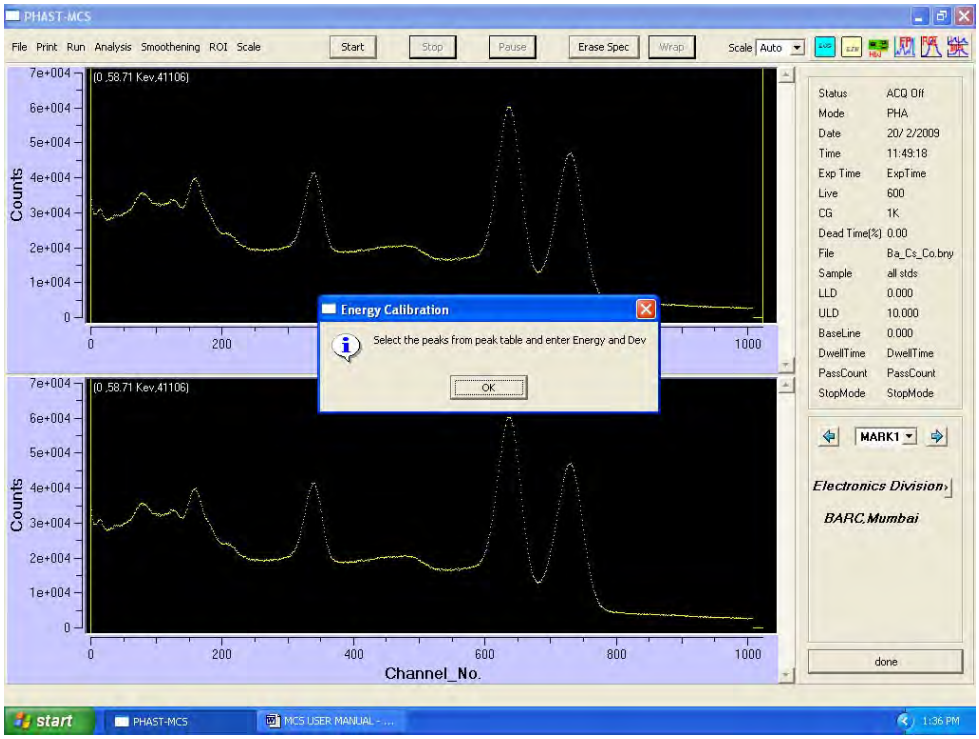


In analysis menu select **energy calibration**

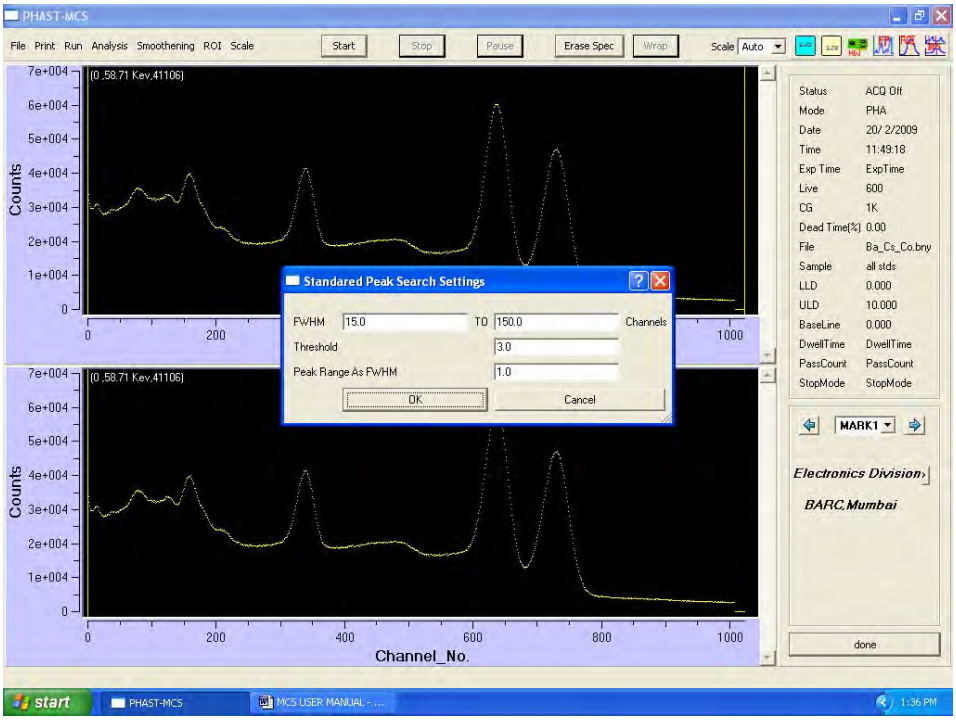


Click '**No**'

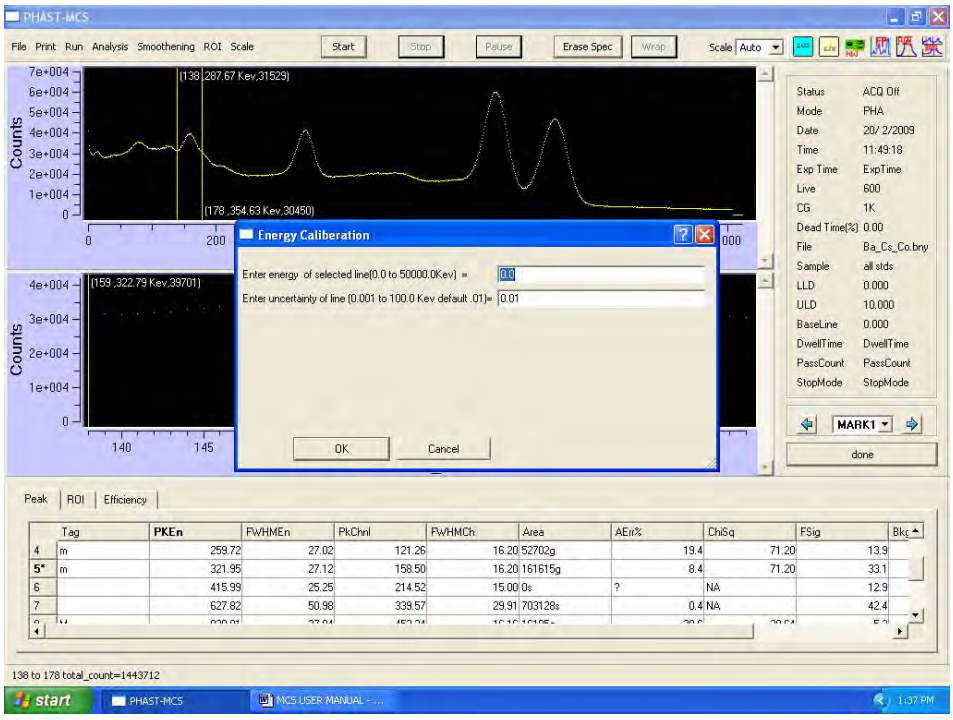
If '**YES** 'is clicked the user will be prompted to enter the three coefficients of second- degree calibration polynomial.



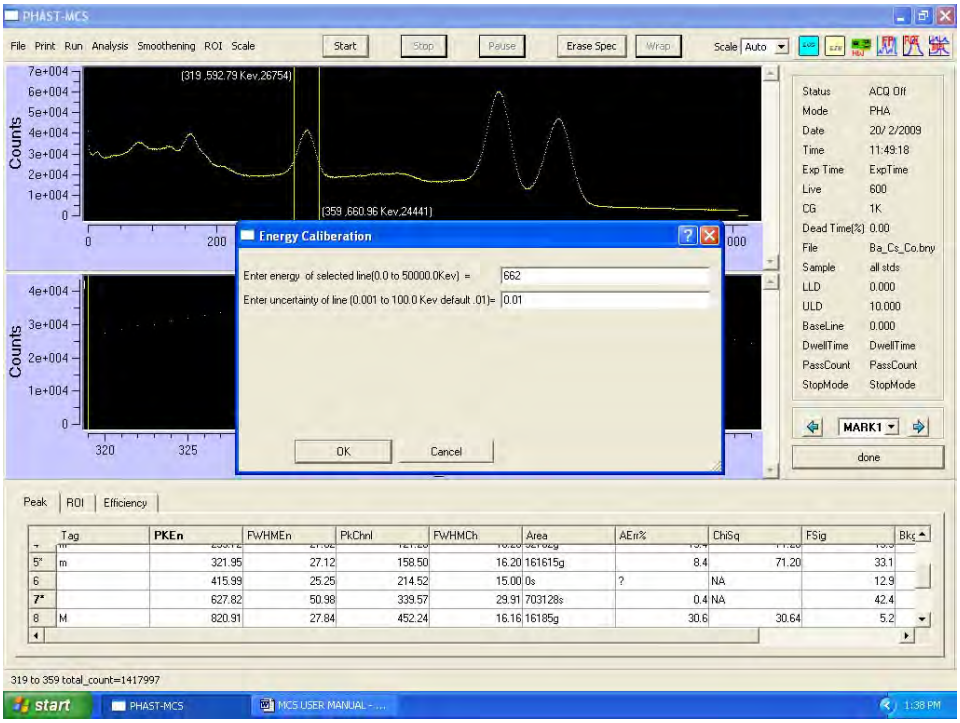
Click '**Ok**'

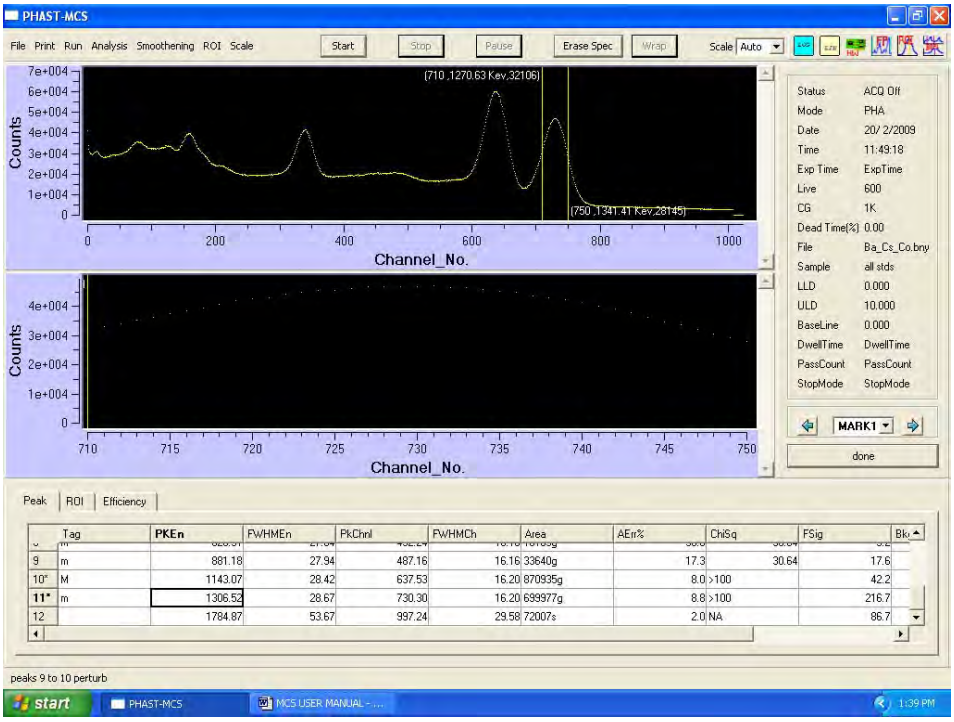


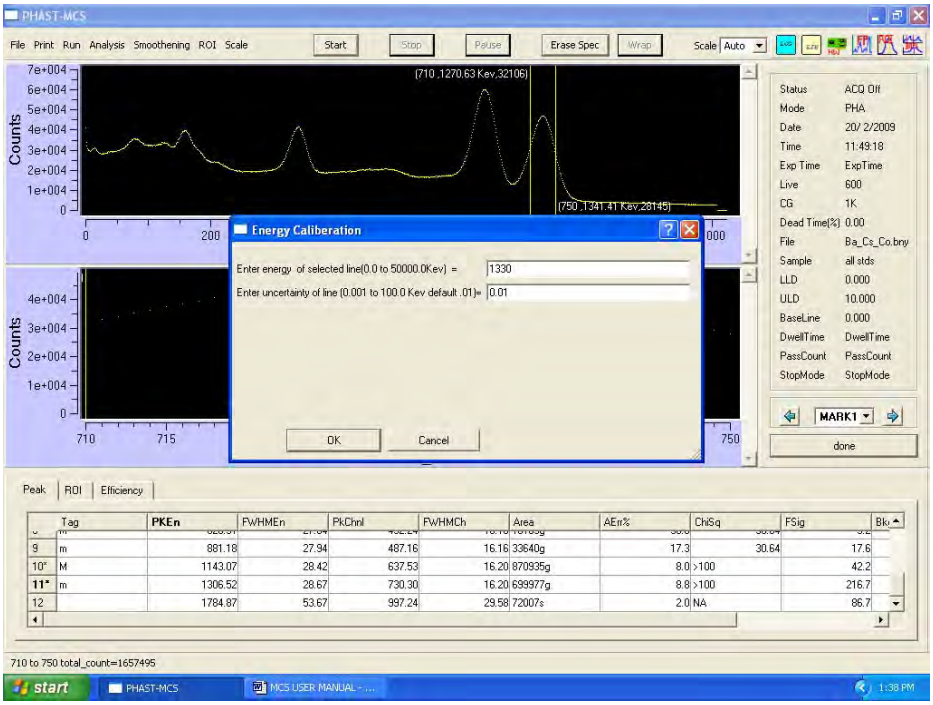
Click ‘Ok’

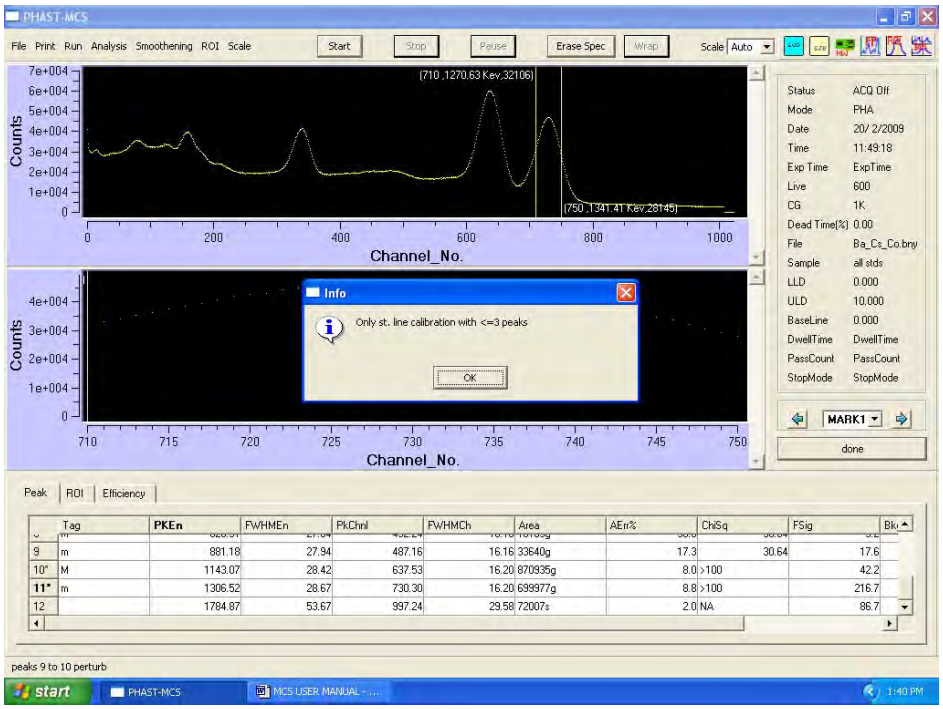


The user should now select energy peaks one by one double clicking on the row of the entry. Click on the PkChnl column and identify the respective energy peak. For each energy peak selected double click in the PkEn box pertaining to that selected energy. Repeat this process for atleast four energy peaks.

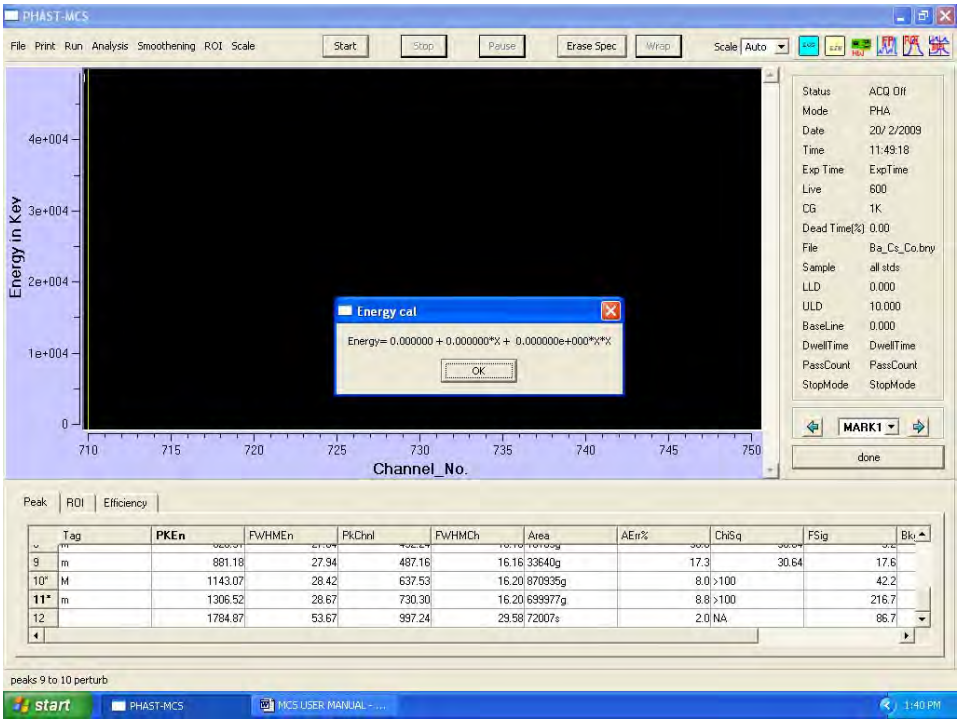

PHAST-MCS
File Print Run Analysis Smoothening ROI Scale
Start
Stop
Pause
Erase Spec
Wrap
Scale Auto
(319 ,592.79 Kev,26754)
(359 ,660.96 Kev,24441)
Counts
Energy Caliberation
Enter energy of selected line(0.0 to 50000.0Kev) =
662
Enter uncertainty of line (0.001 to 100.0 Kev default .01)=
0.01
OK
Cancel
Status ACQ Off
Mode PHA
Date 20/ 2/2009
Time 11:49:18
Exp Time ExpTime
Live 600
CG 1K
Dead Time(%) 0.00
File Ba_Cs_Co.bny
Sample all stds
LLD 0.000
ULD 10.000
BaseLine 0.000
DwellTime DwellTime
PassCount PassCount
StopMode StopMode
MARK1
done
Peak
ROI
Efficiency
Tag PKEn FWHMEn PkChnl FWHMCh Area AErr% ChiSq FSig
5' m 321.95 27.12 158.50 16.20 161615g 8.4 71.20 33.1
6 415.99 25.25 214.52 15.00 0s ? NA 12.9
7* 627.82 50.98 339.57 29.91 703128s 0.4 NA 42.4
8 M 820.91 27.84 452.24 16.16 16185g 30.6 30.64 5.2
319 to 359 total_count=1417997
start
PHAST-MCS
MCS USER MANUAL - ...
1:38 PM


PHAST-MCS
File Print Run Analysis Smoothening ROI Scale
Start
Stop
Pause
Erase Spec
Wrap
Scale Auto
(710 ,1270.63 Kev,32106)
(750 ,1341.41 Kev,28145)
Counts
Channel_No.
Status ACQ Off
Mode PHA
Date 20/ 2/2009
Time 11:49:18
Exp Time ExpTime
Live 600
CG 1K
Dead Time(%) 0.00
File Ba_Cs_Co.bny
Sample all stds
LLD 0.000
ULD 10.000
BaseLine 0.000
DwellTime DwellTime
PassCount PassCount
StopMode StopMode
MARK1
done
Peak
ROI
Efficiency
Tag PKEn FWHMEn PkChnl FWHMCh Area AErr% ChiSq FSig
9 m 881.18 27.94 487.16 16.16 33640g 17.3 30.64 17.6
10* M 1143.07 28.42 637.53 16.20 870935g 8.0 >100 42.2
11* m 1306.52 28.67 730.30 16.20 699977g 8.8 >100 216.7
12 1784.87 53.67 997.24 29.58 72007s 2.0 NA 86.7
peaks 9 to 10 perturb
start
PHAST-MCS
MCS USER MANUAL - ...
1:39 PM

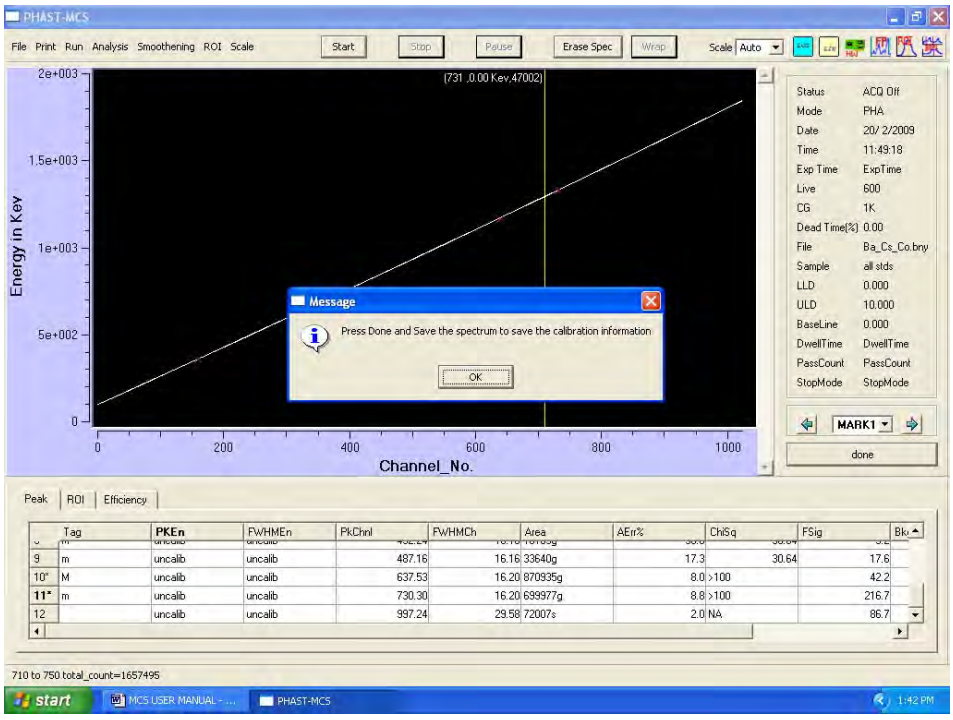




Once the desired number of peaks (minimum3) is entered, the done button has to be pressed to complete the calibrations process and calibration polynomials are displayed in a dialog box as shown below.

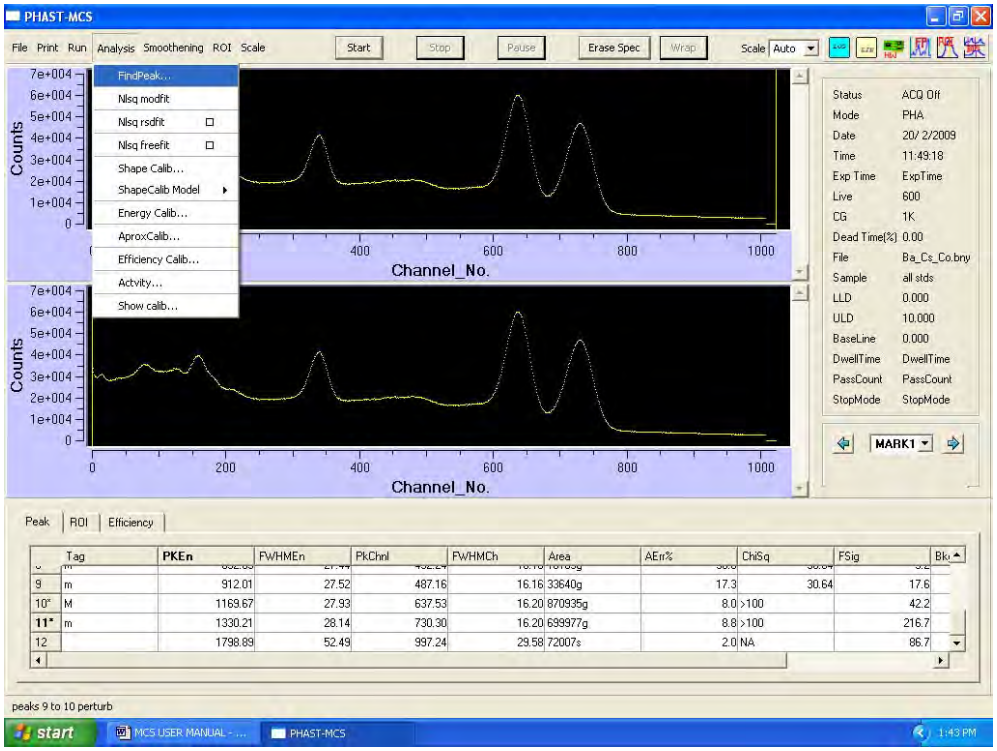


Click **Ok** in **energy cal window**
We will find a linearity curve as shown below

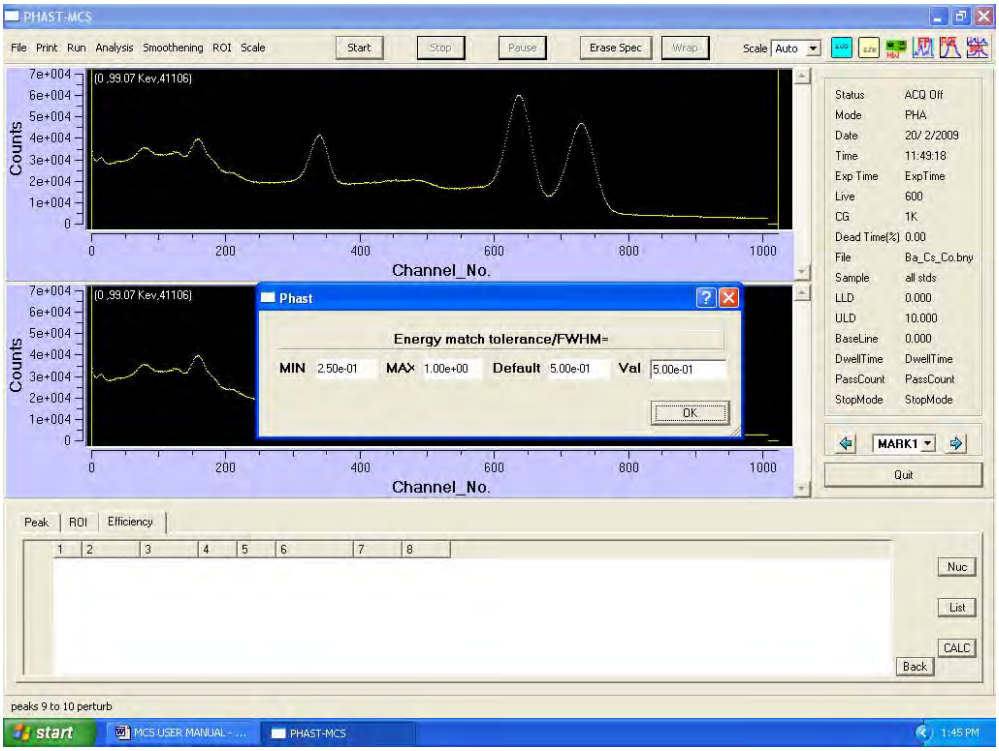


Press **done** seen on the right side (lower) of the screen has to be clicked for normal restoration of the software.
With this above process **energy calibration** is completed.

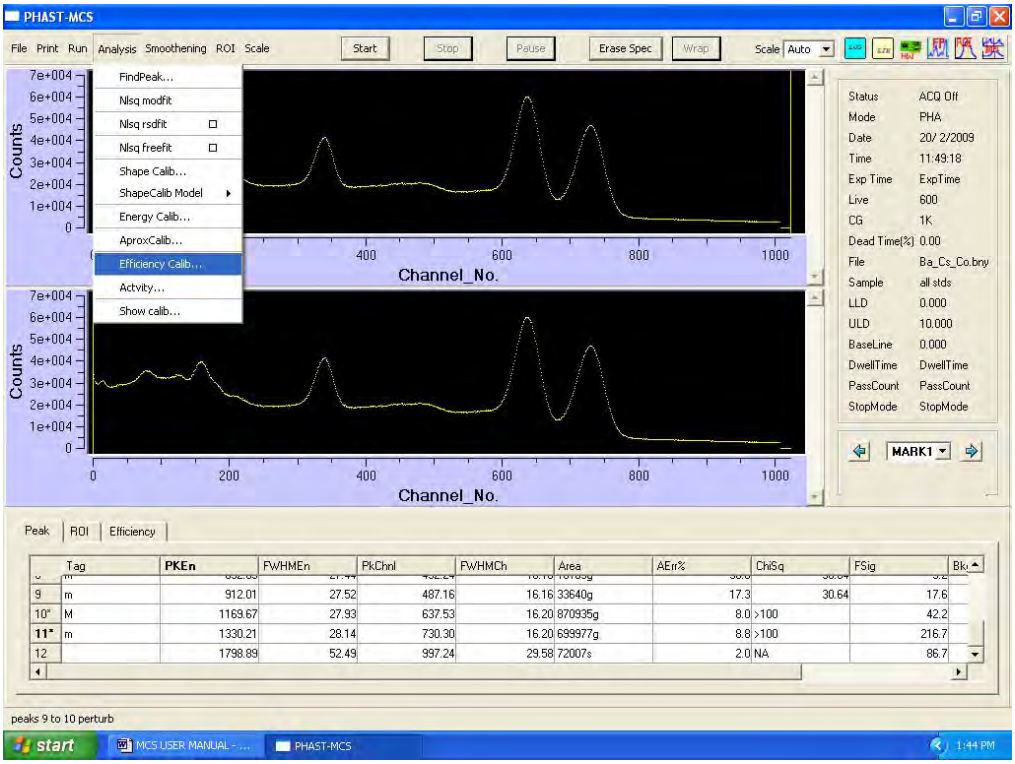
Procedure for Efficiency calibration



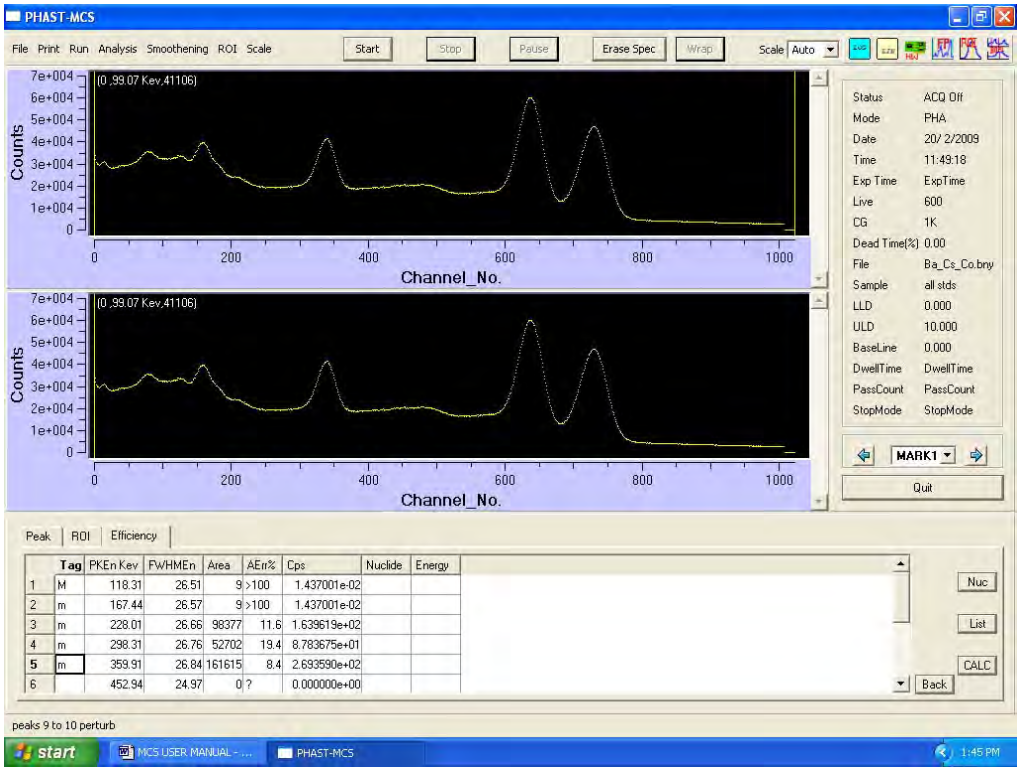
To do **efficiency calibration** the spectrum is first analyzed with **find peak** as shown.



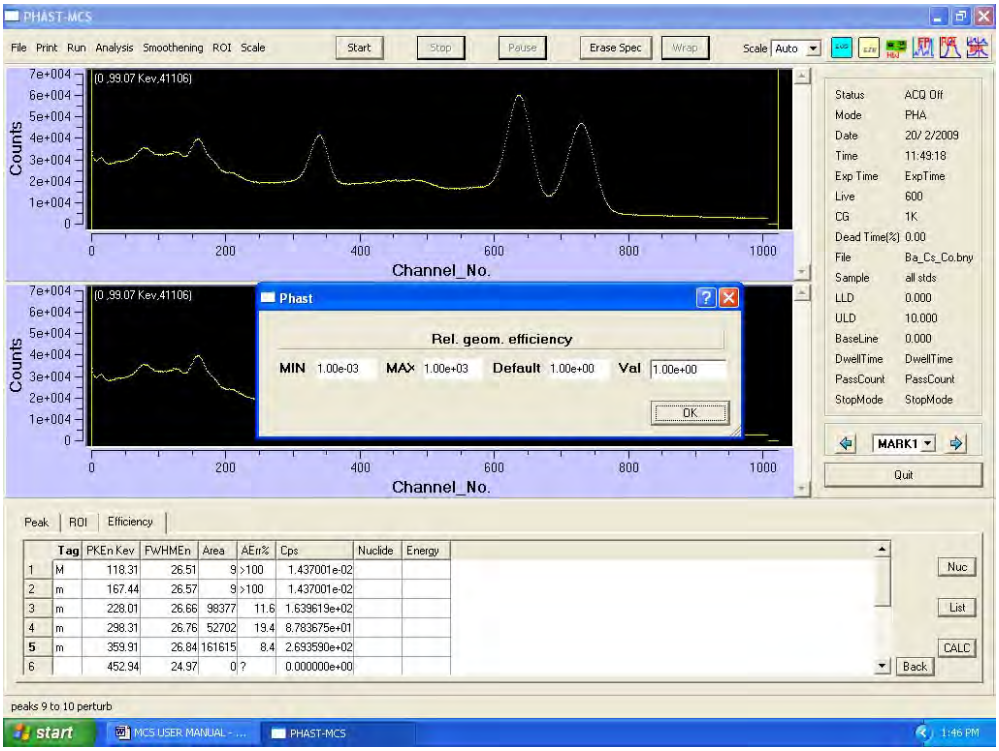
Then **Efficiency calibration** is pressed from the **analysis menu**



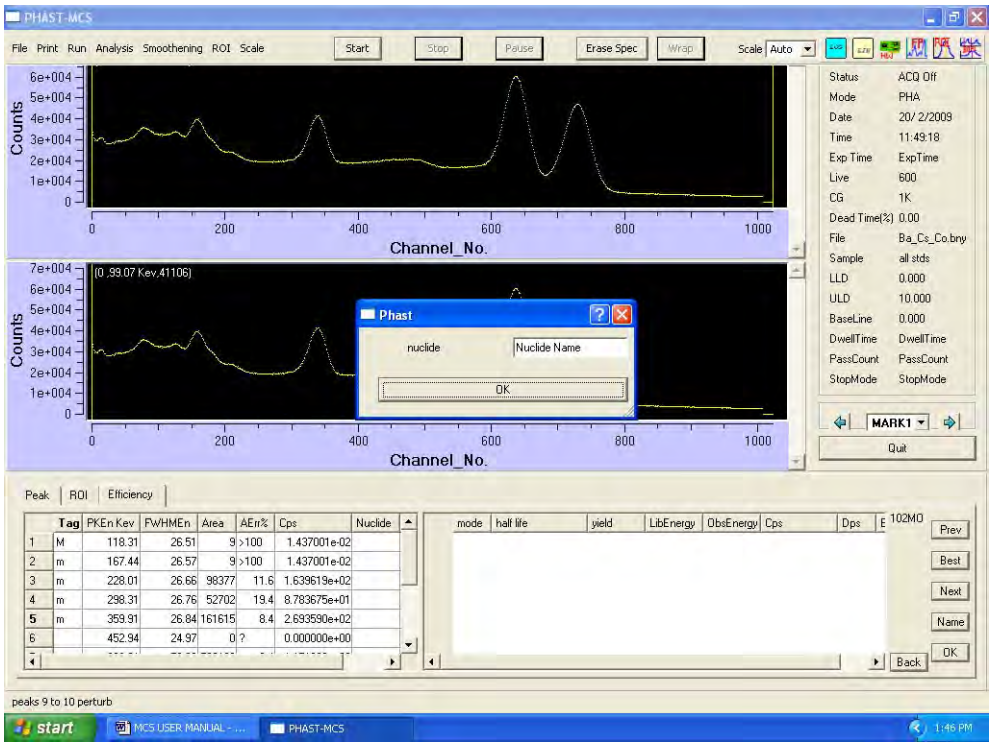
In **analysis** menu select **efficiency calibration**



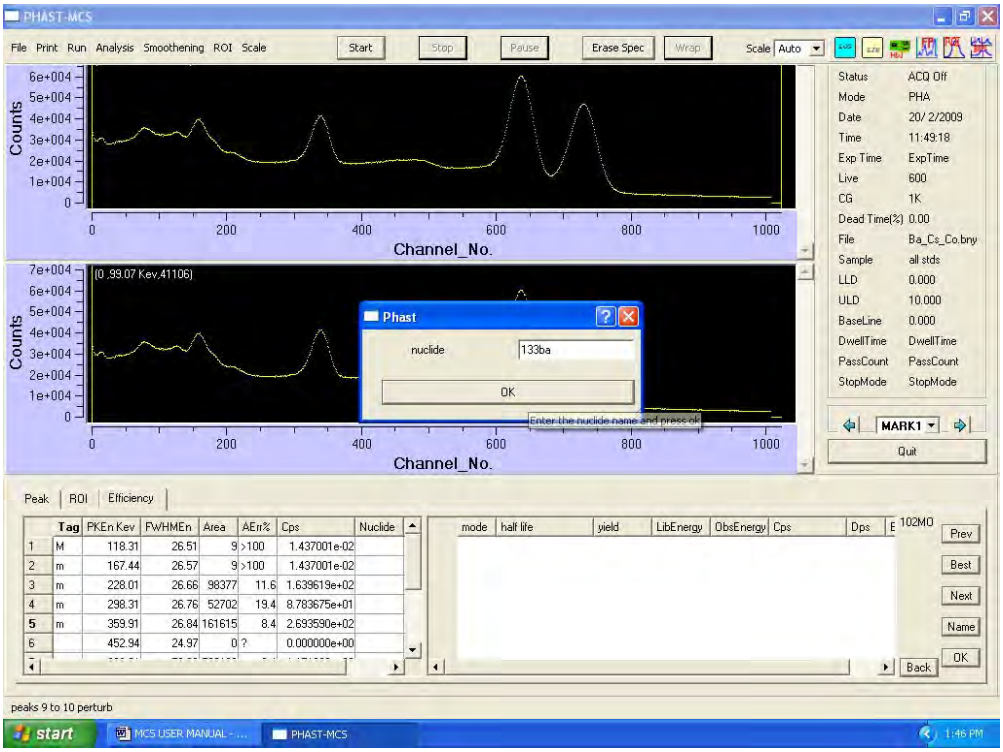
Select the nuclide from the table by single click and the tag will be **squared** as shown in the above figure.

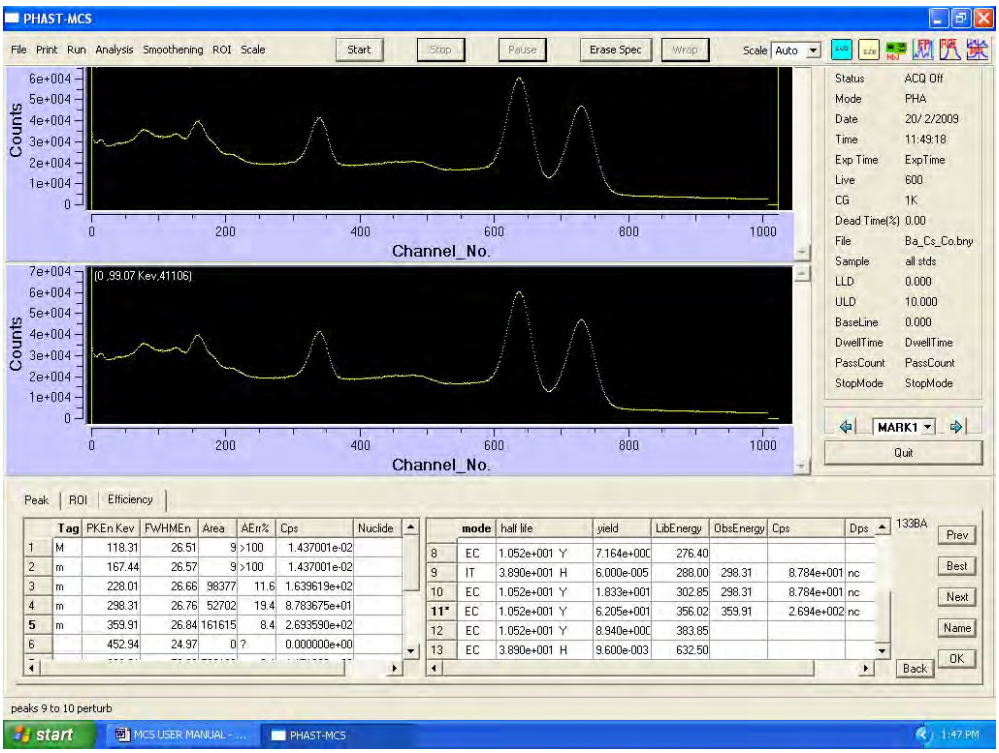


The user is first prompted to enter the **relative geom.Efficieny** on clicking the **Nuc** button on the **right hand side** ,the default value of the 1 may be used and click '**Ok**'.

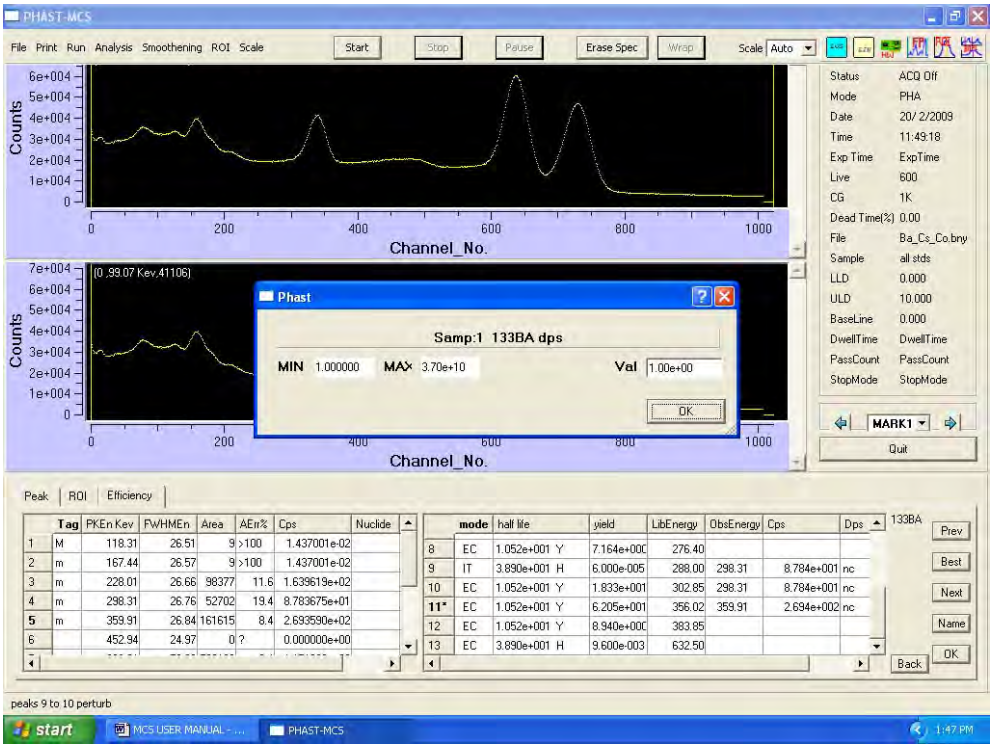


By clicking the **Name** on the right hand side **nuclide window** will be **popped up** and enter the **nuclide name** (first atomic number and next name of nuclide eg:133ba,137cs etc) and click **Ok.**

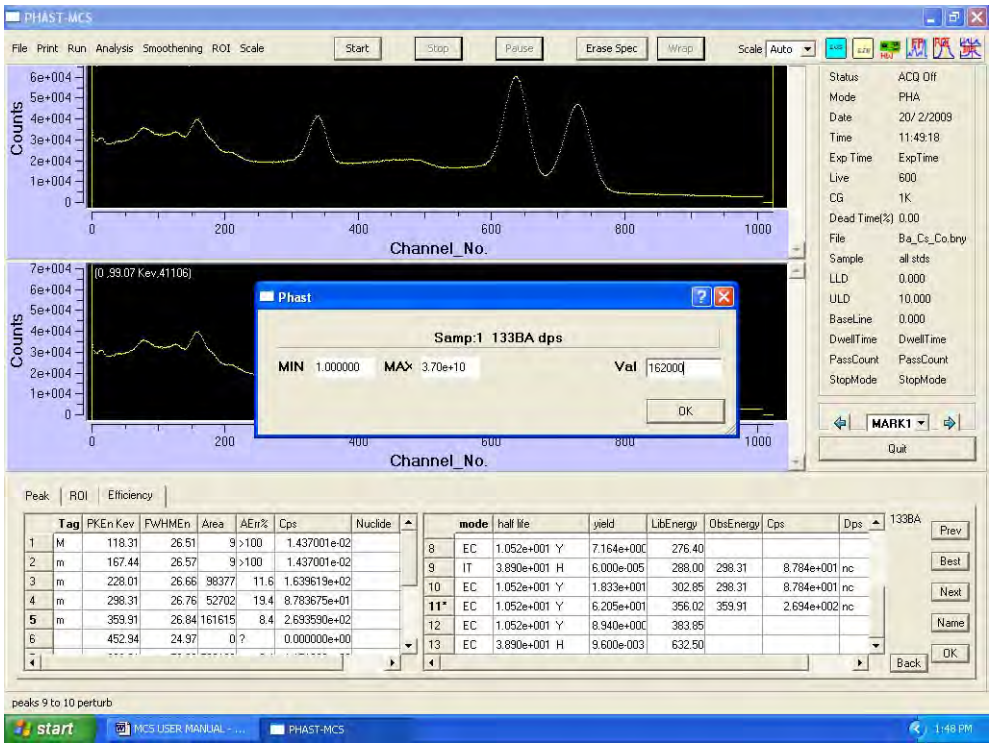




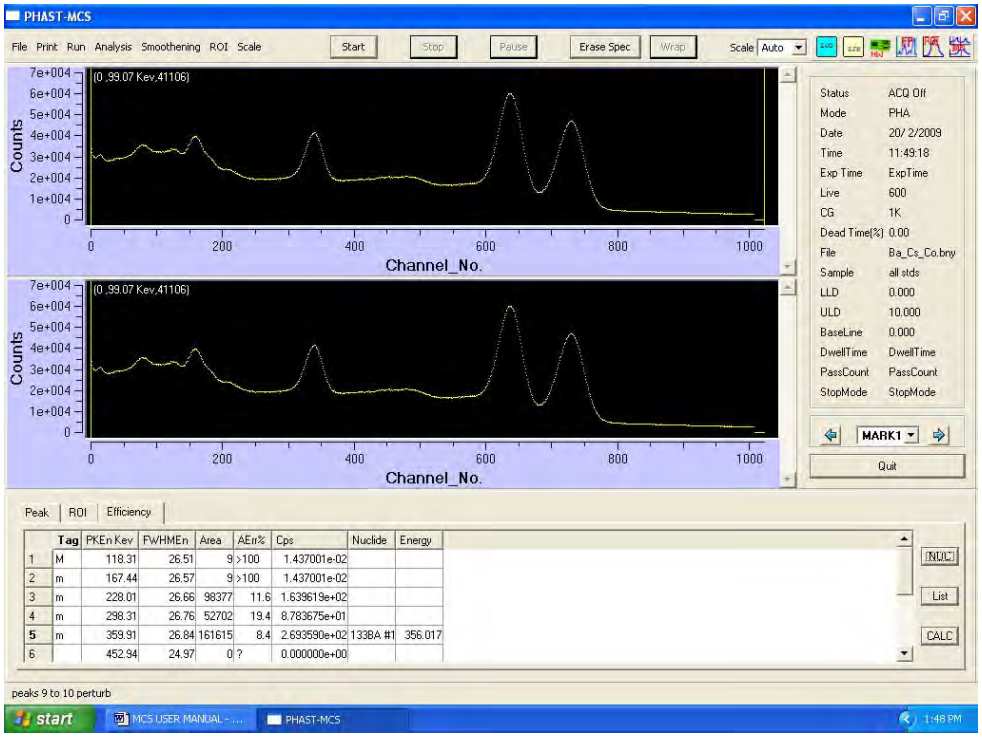
Double click on the correct nuclide in **right hand side** and '*' will appear as shown in the above window.



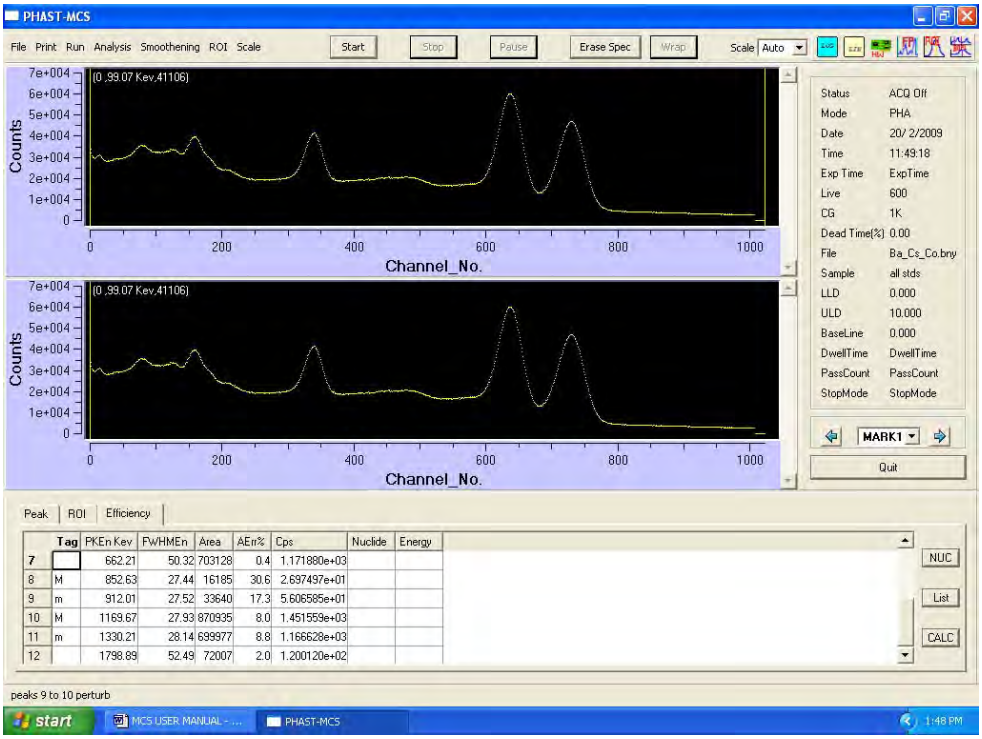
Click '**Ok**' **in right hand side** and **dps window** will be **popped up.**



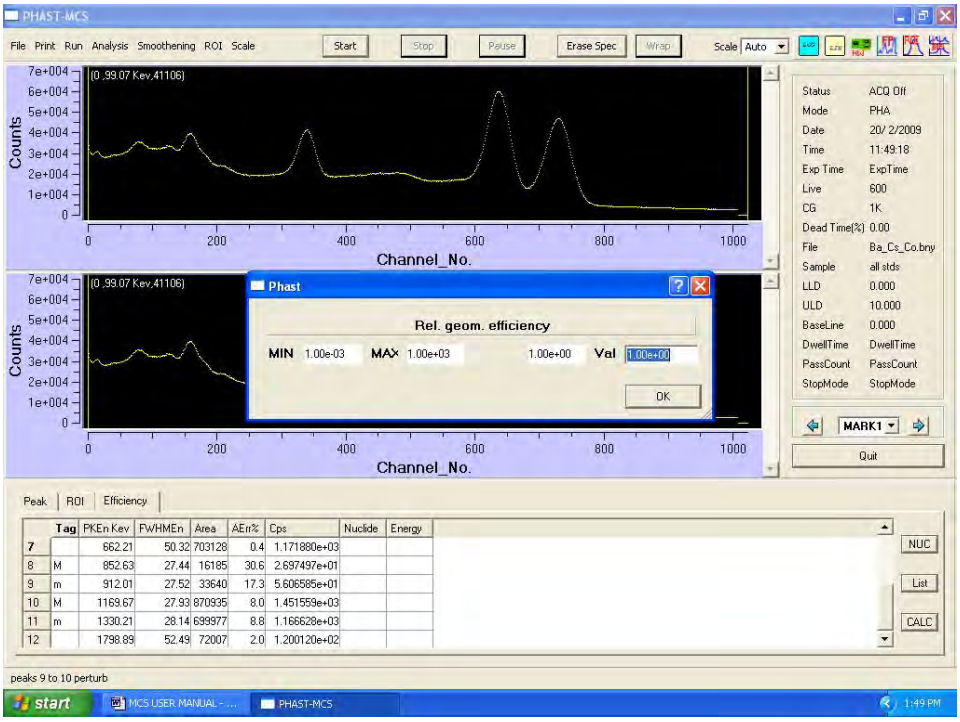
Enter the **dps value** of **source as on date** and click **Ok**



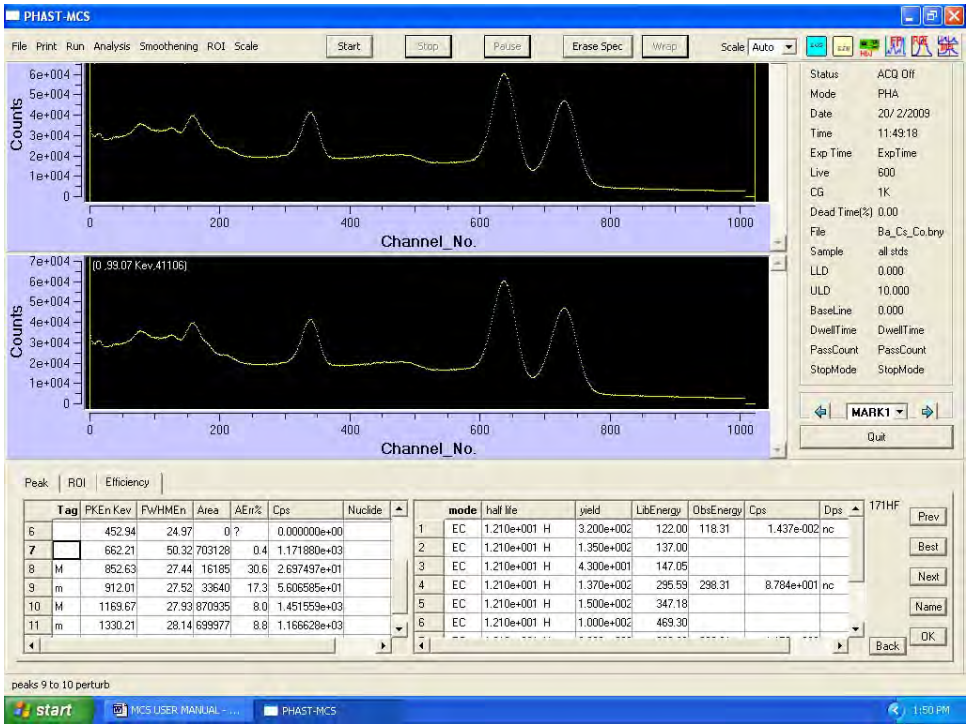
Now the corresponding nuclide and energy will be appeared in left side as shown in the above window.



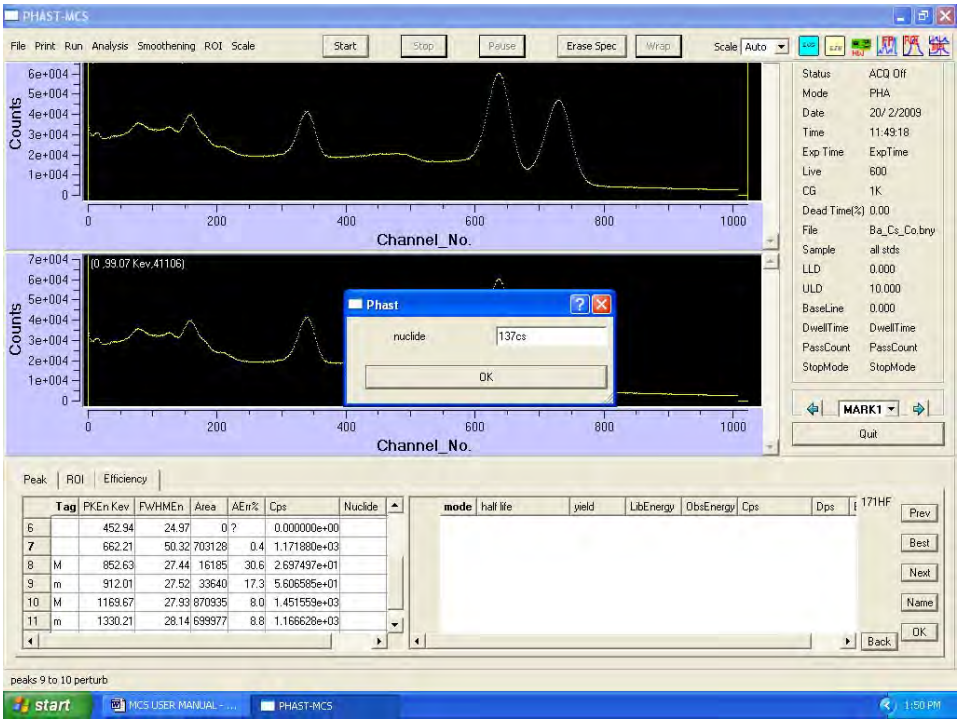
Again select the nuclide from the table by single click and the tag will be **squared** as shown in the above figure and repeat the above steps



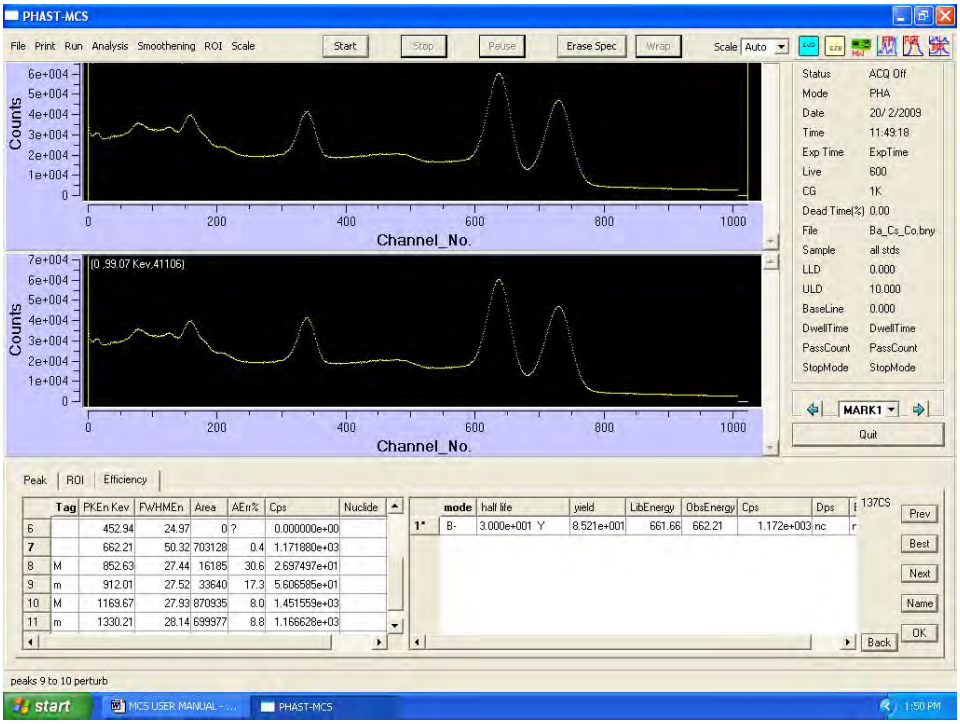
Click '**Nuc**'
Click '**Ok**'



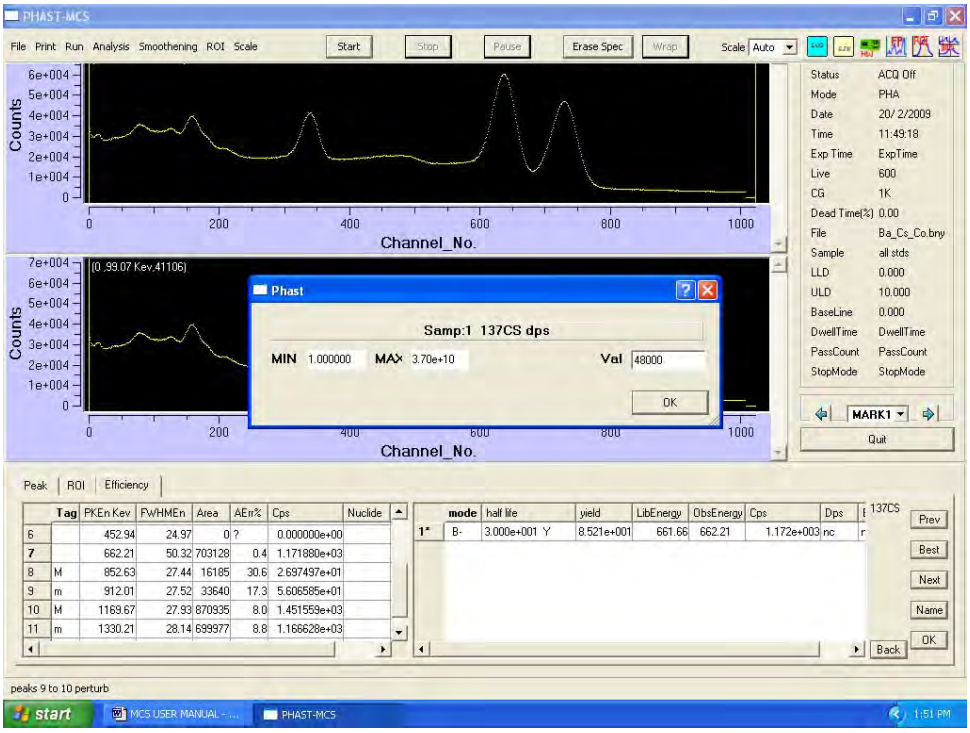
Click **Name**



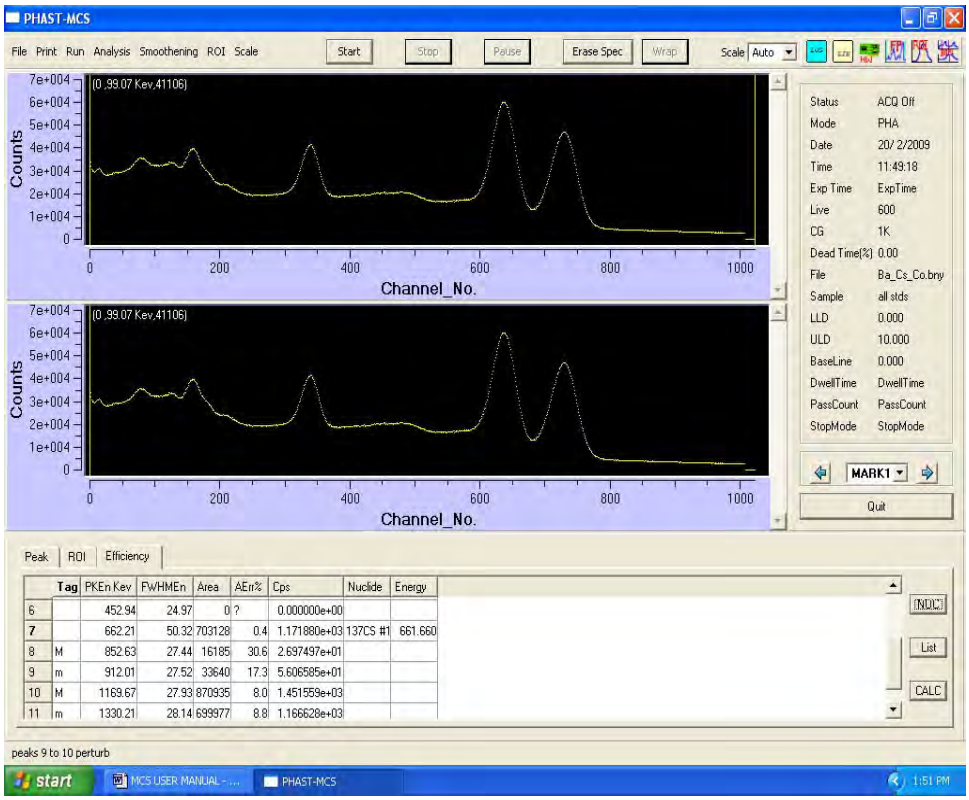
Enter the **Nuclide Name**



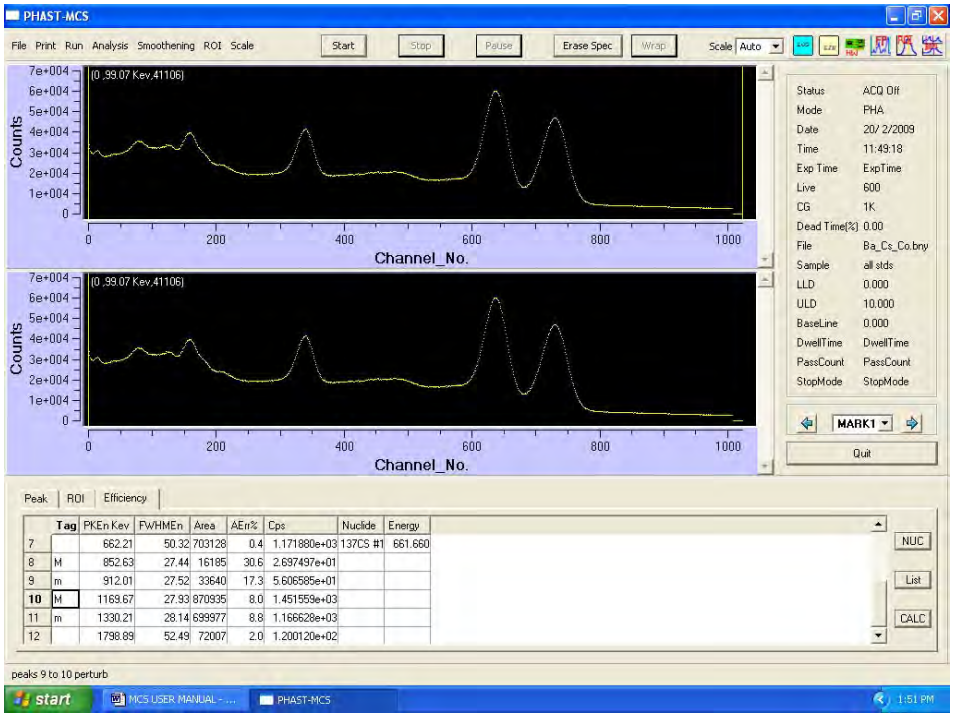
Double click the **Nuclide in the left hand side** and click **Ok**



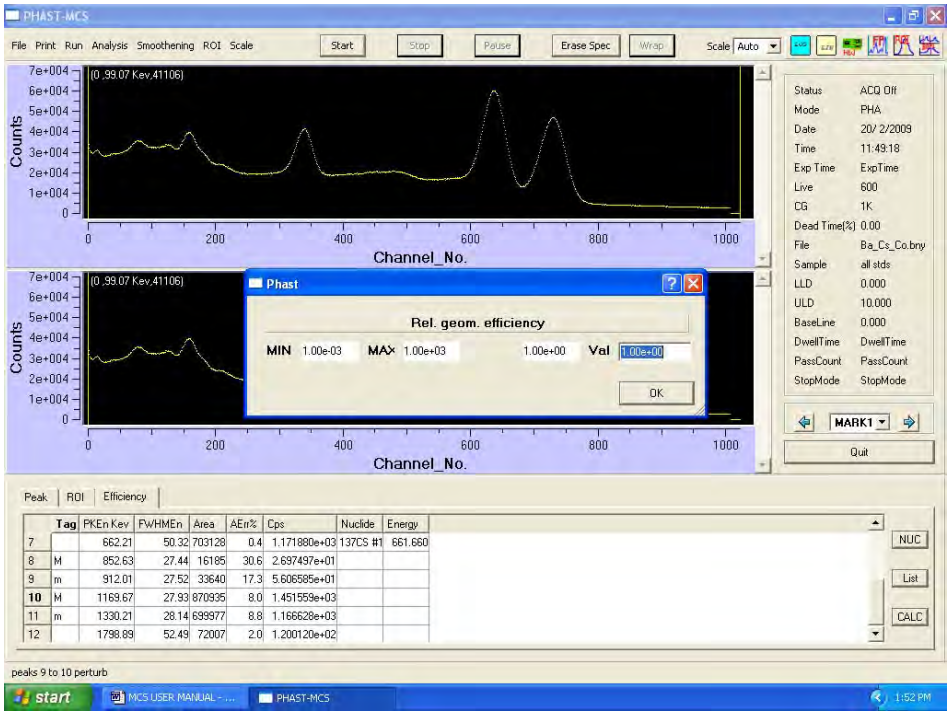
Enter the **dps value** of the **nuclide** and click **'Ok'**



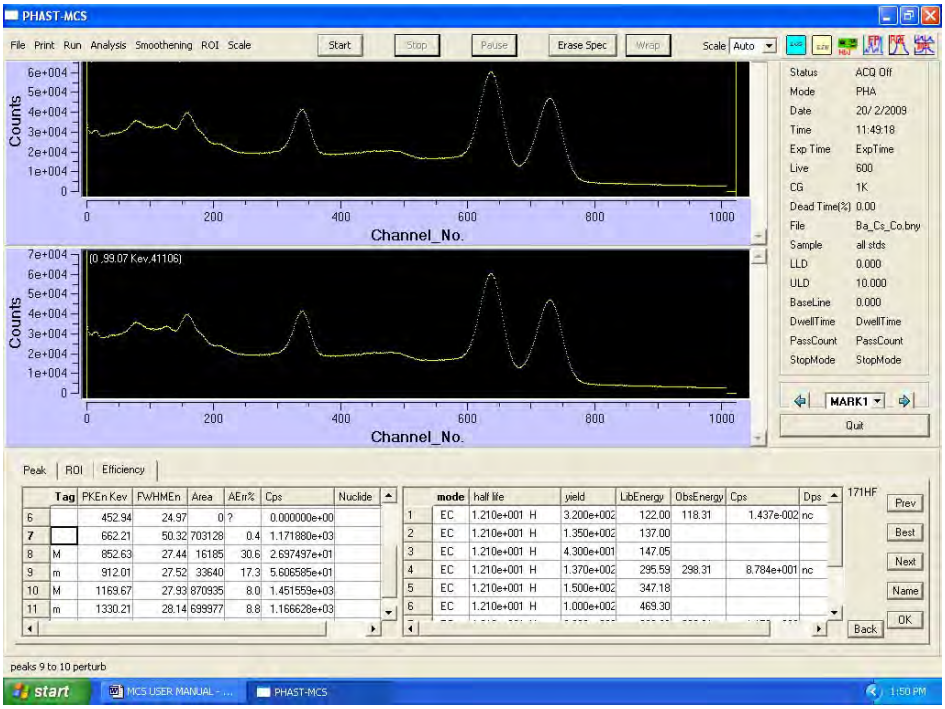
Now the corresponding **nuclide** and **energy** will be appeared in left side as shown in the above window.



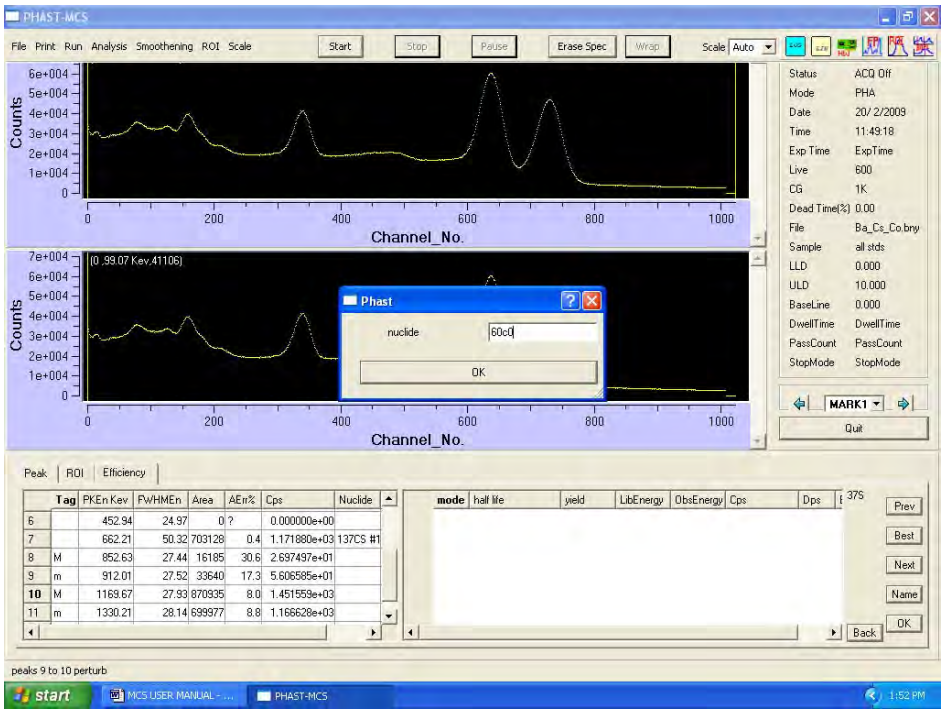
Again select the **nuclide** from the table by single click and the tag will be squared as shown in the above figure and repeat the above steps.



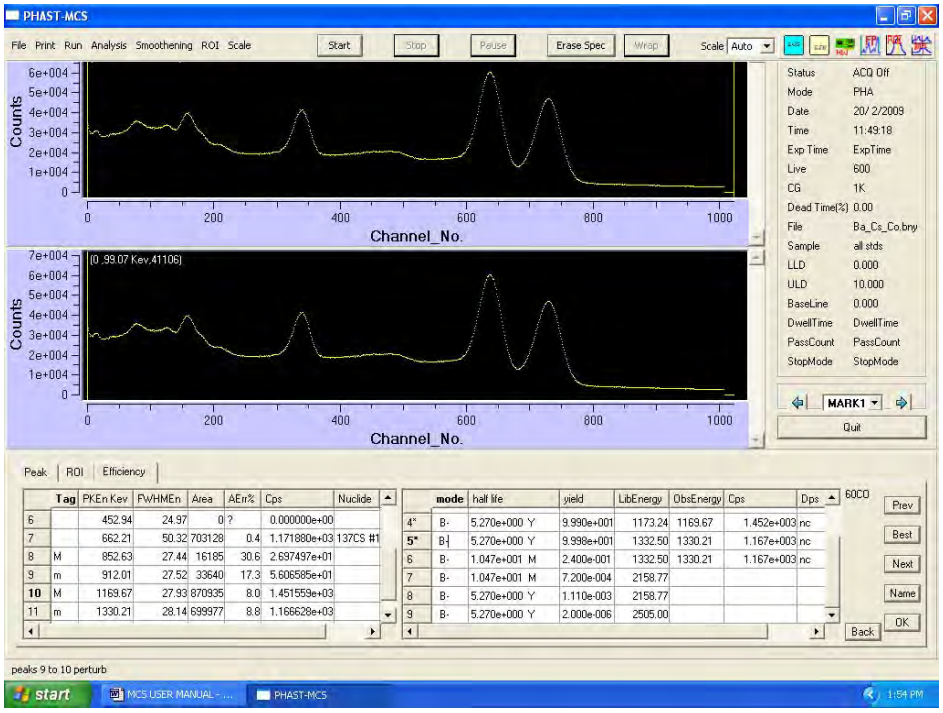
Click '**Nuc**'
Click '**Ok**'



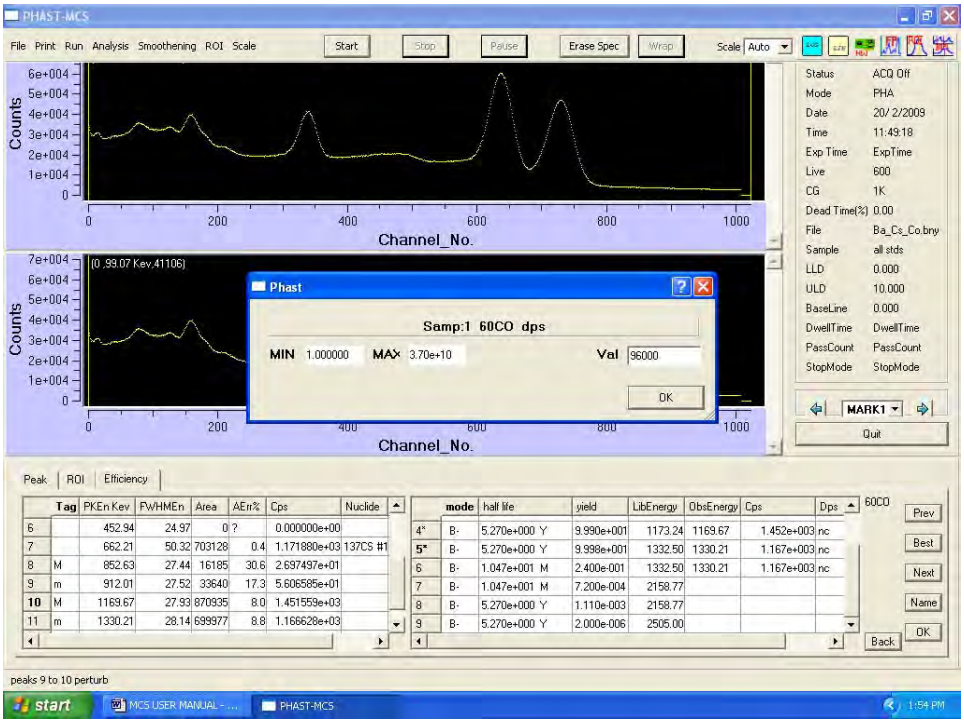
Click **Name**



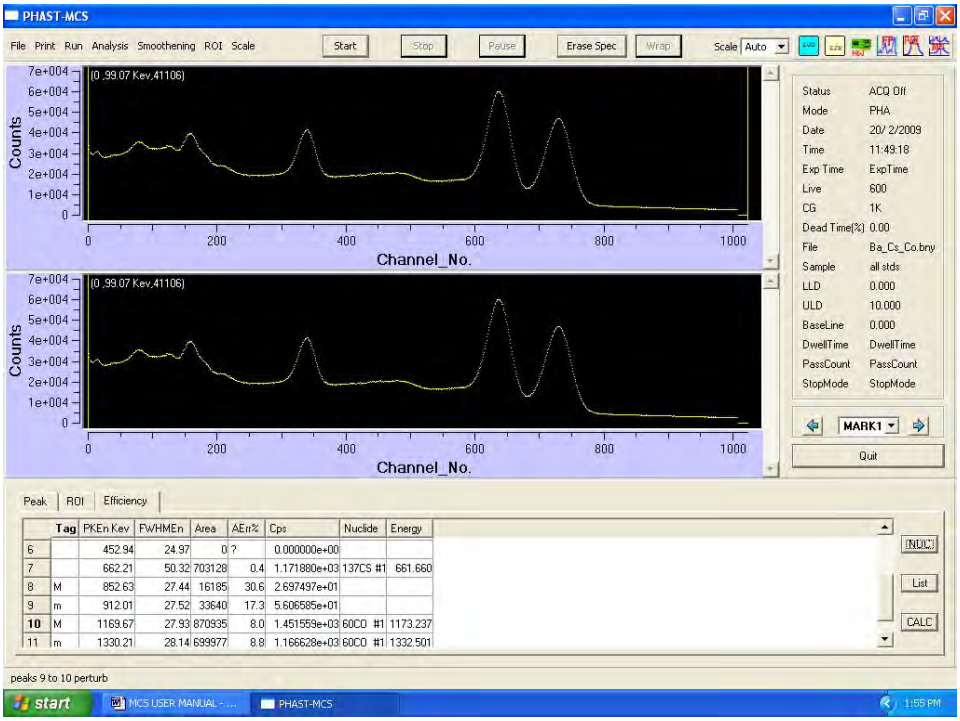
Enter the **nuclide name**



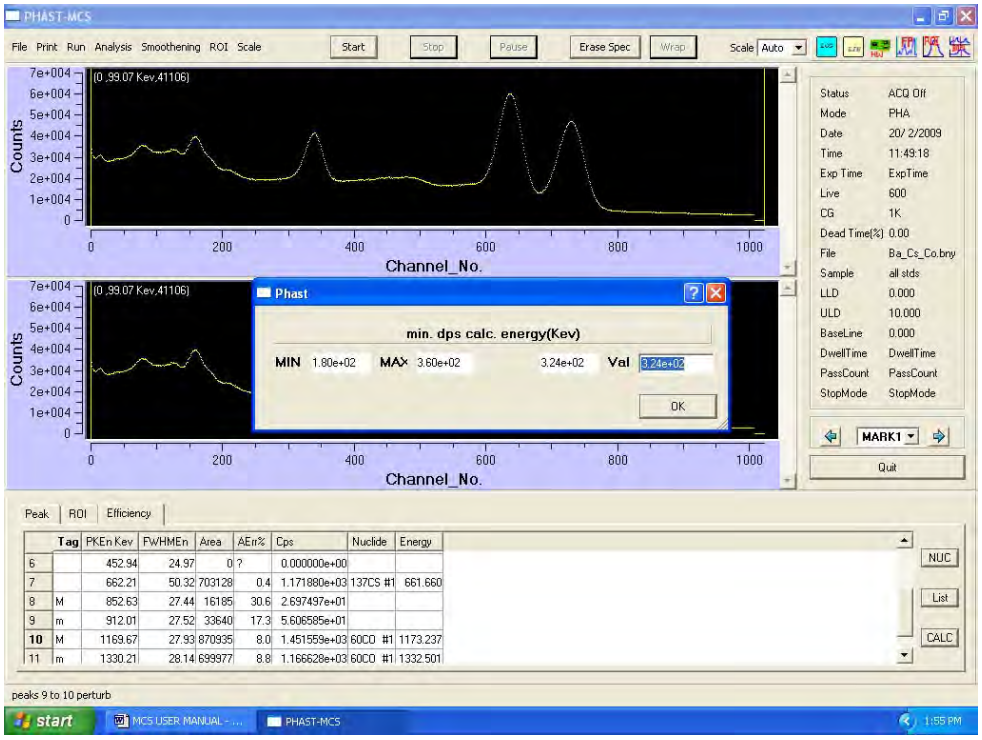
Double click the **Nuclide in the left hand side** and click **Ok**



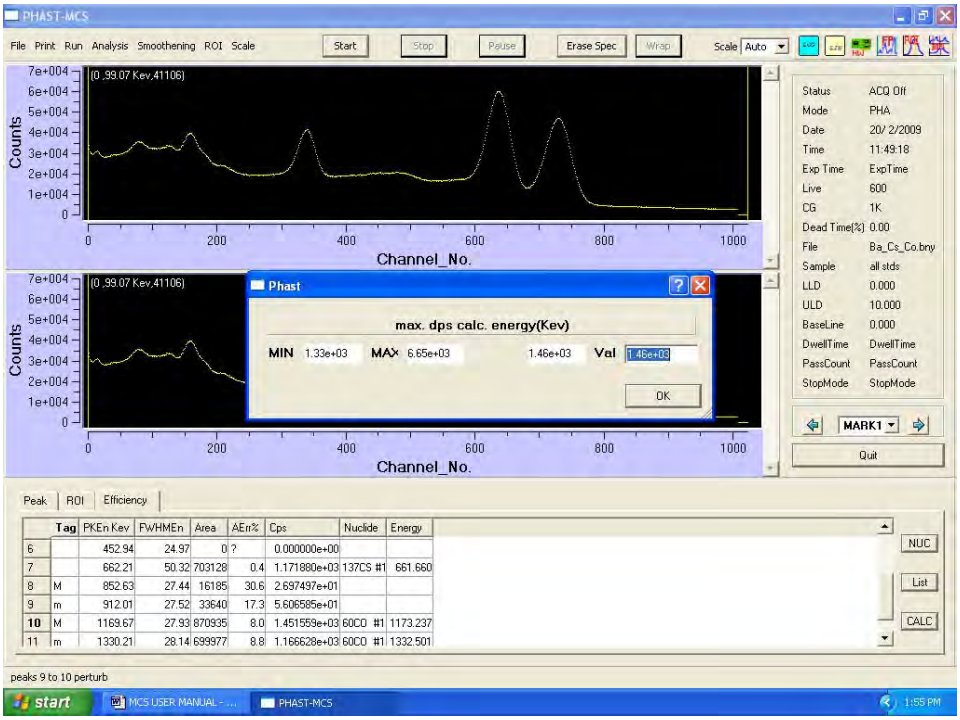
Enter the **dps** value of the nuclide



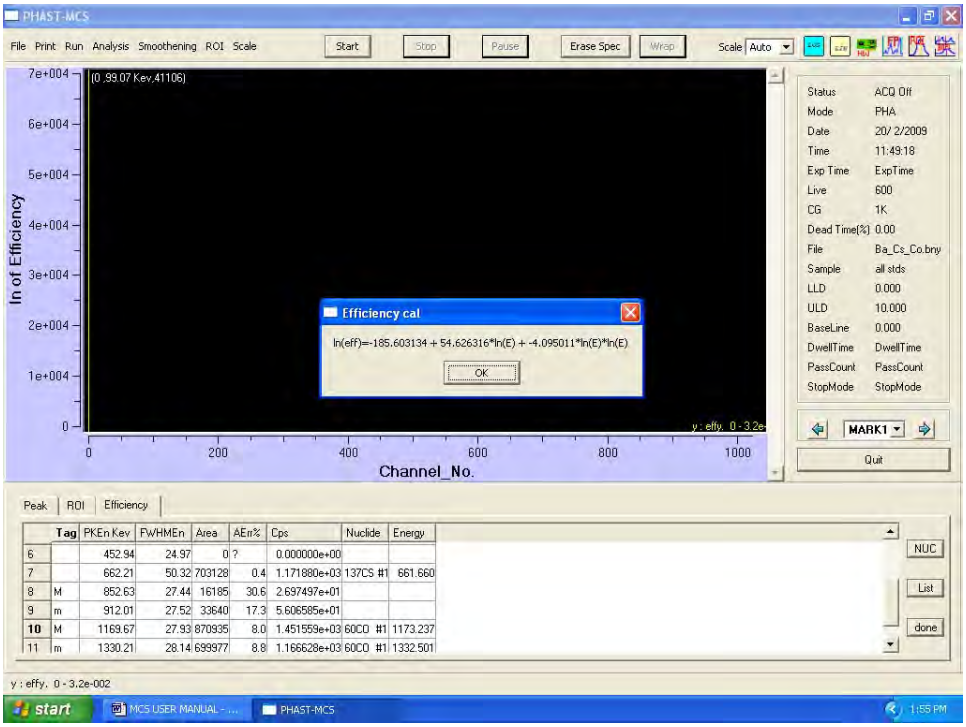
Click ‘CALC’



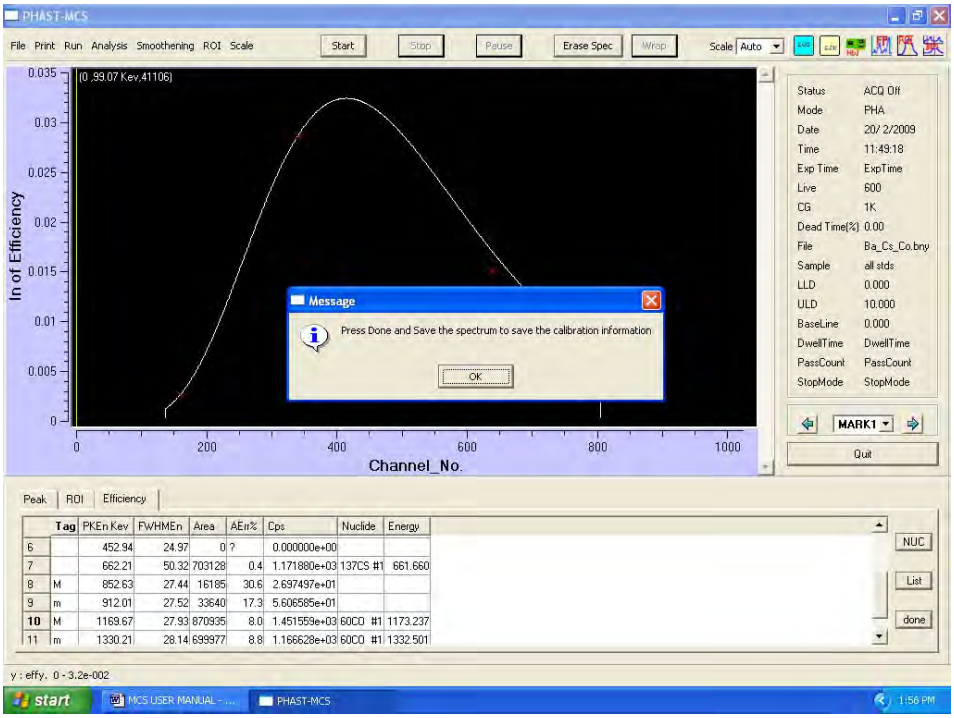
Click ‘Ok’



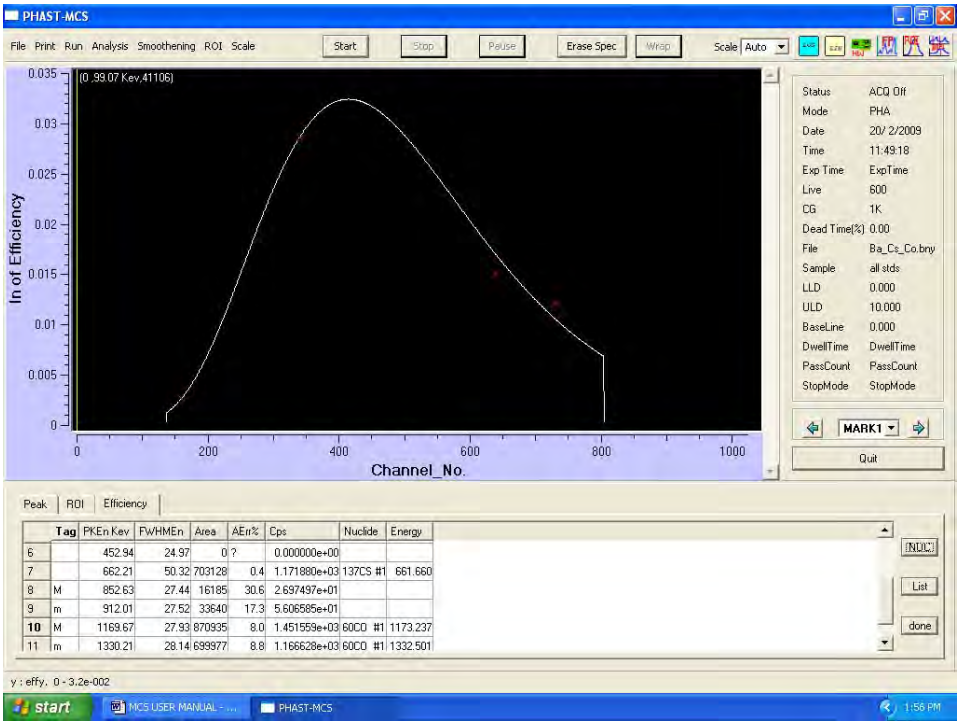
Click ‘Ok’



Efficiency calibration equation will appear and click ‘**Ok**’ to obtain the efficiency curve.



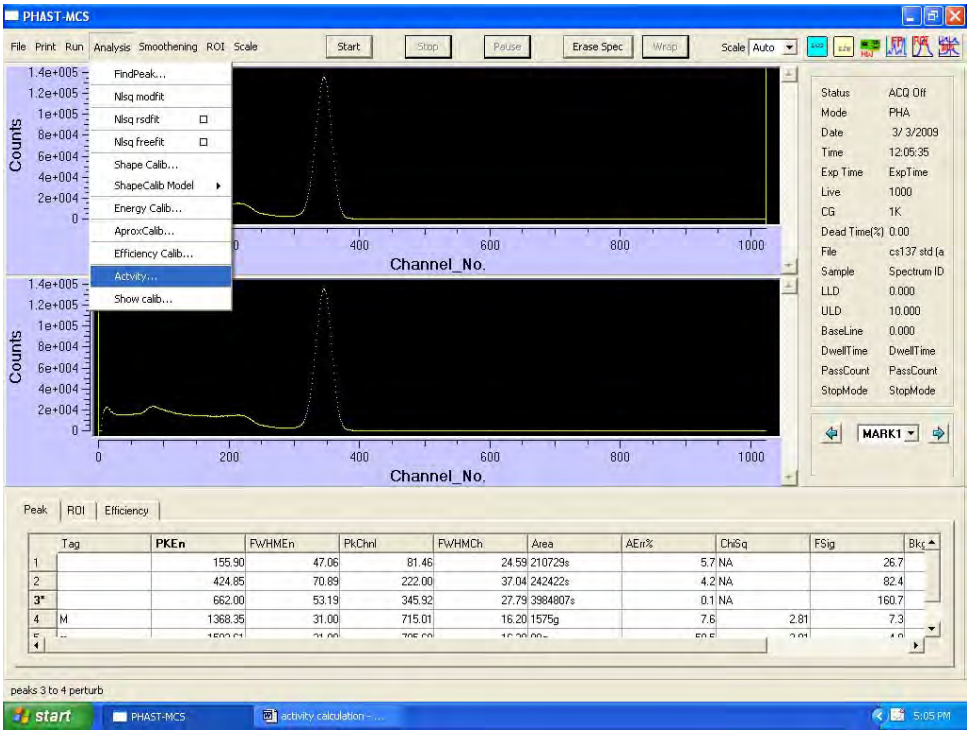
The above window shows the **efficiency curve.**



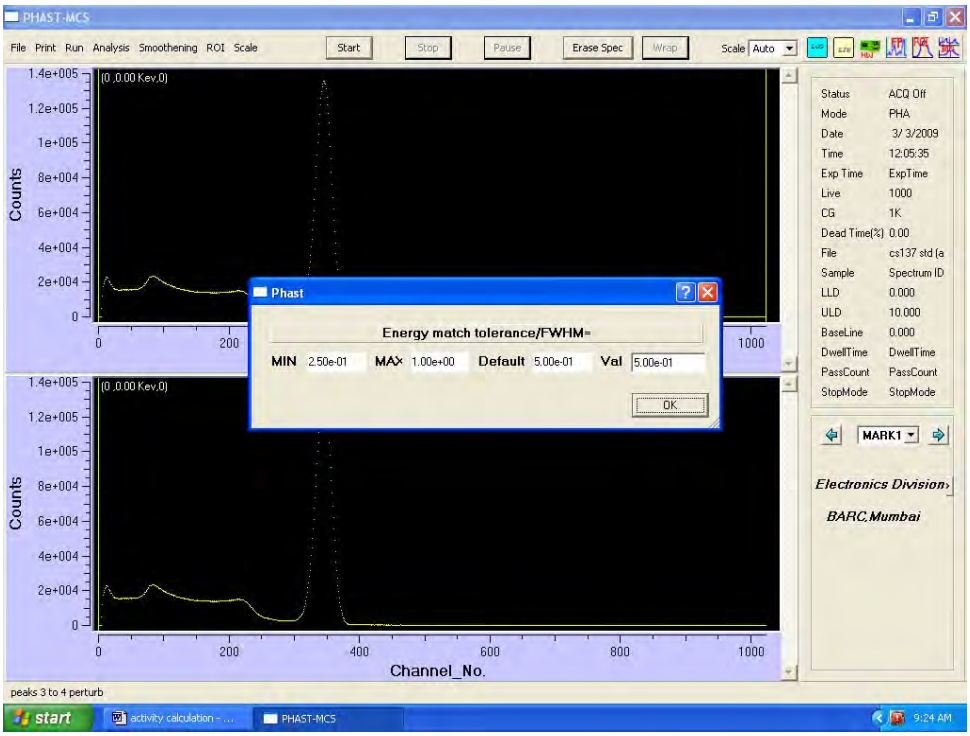
This completes Efficiency calibration

Procedure Activity calculation

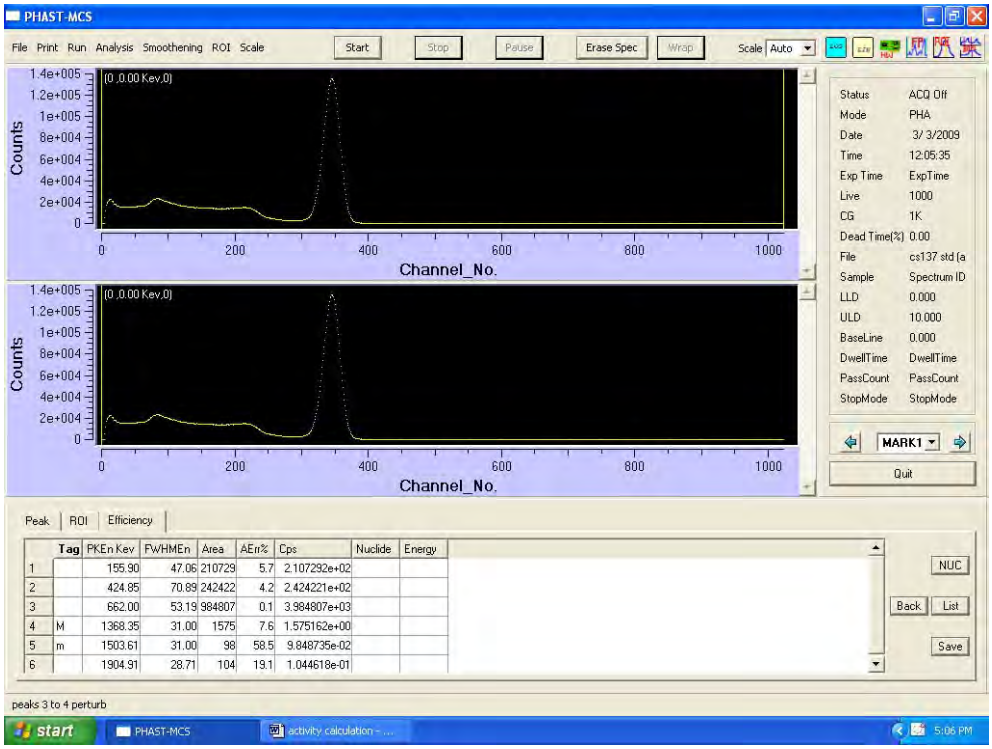
This option is for calculating the activity of the unknown samples if the efficiency calibration is available.



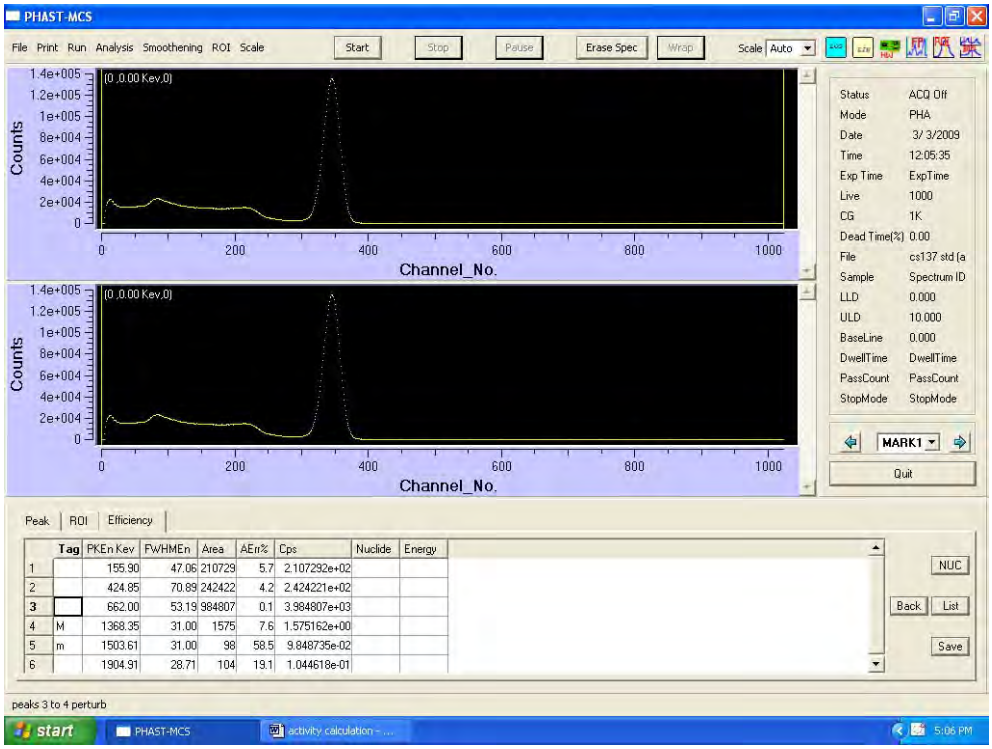
In analysis menu click '**activity**'



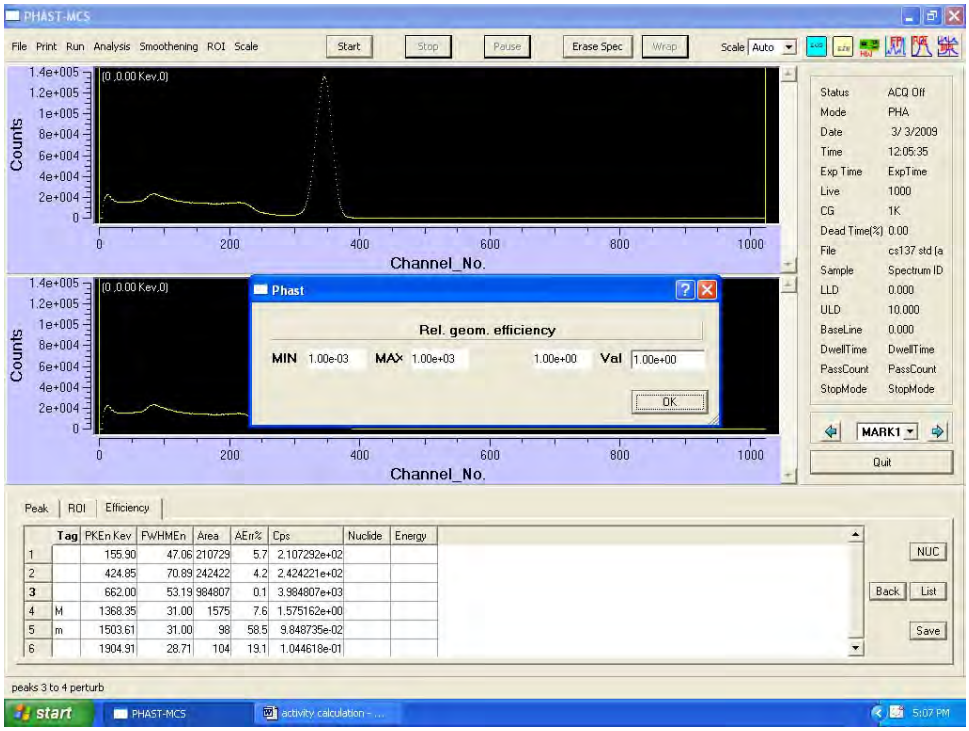
The user is prompted for Energy match tolerance/FWHM ratio.Clic



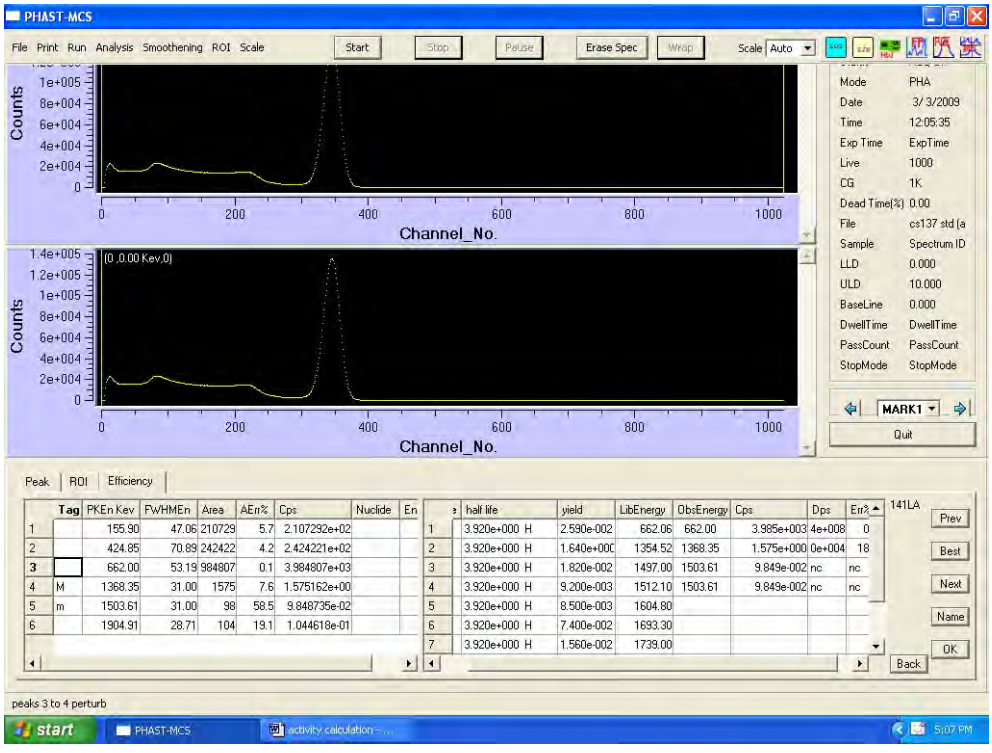
The user is then presented with a display very similar to nuclide navigation display as for the efficiency calibration.



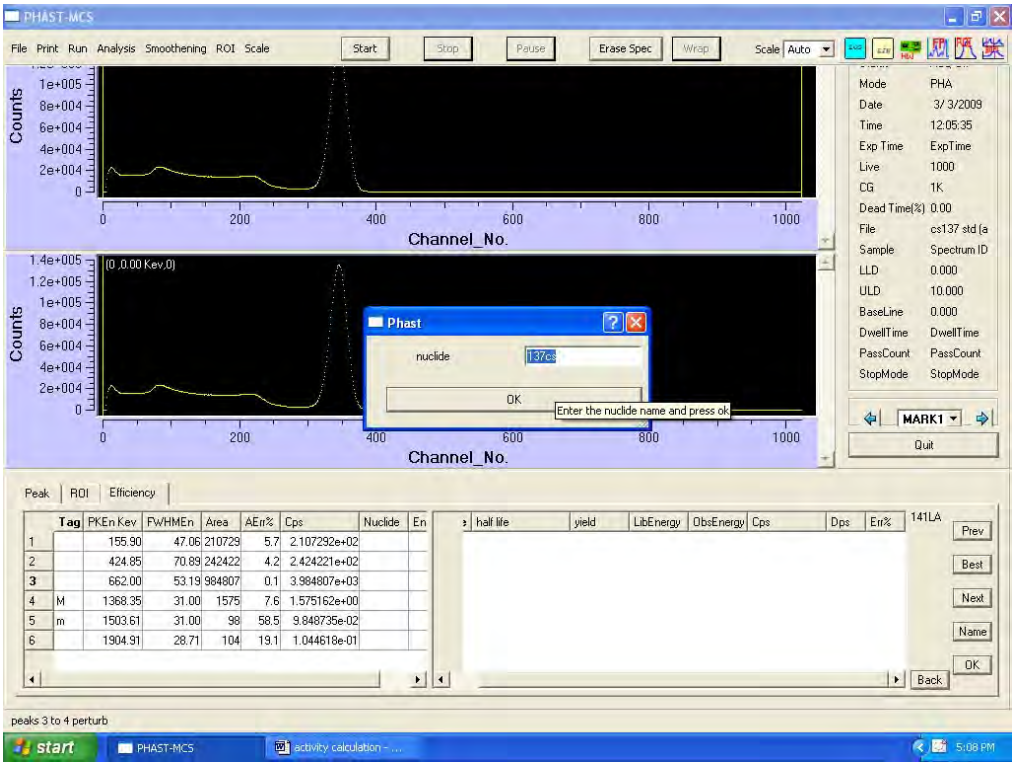
Select the nuclide from the table by single click and the tag will be **squared** as Shown in the above figure



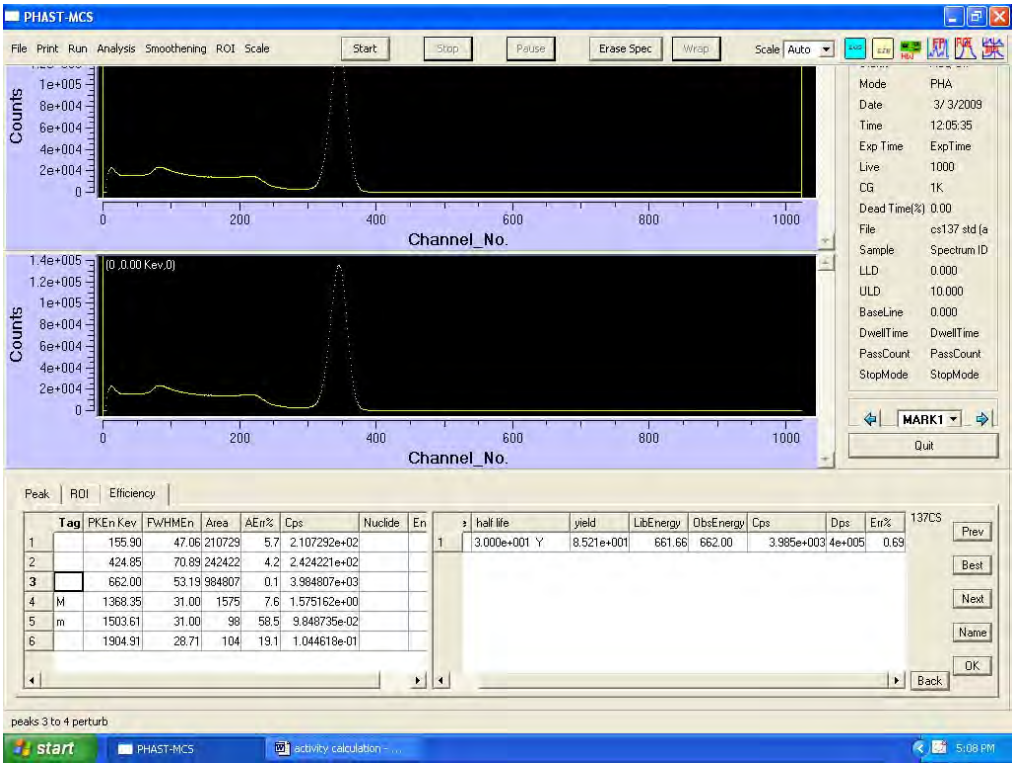
Enter the relative geometric efficiency or the default value may be used And click'**Ok**'.



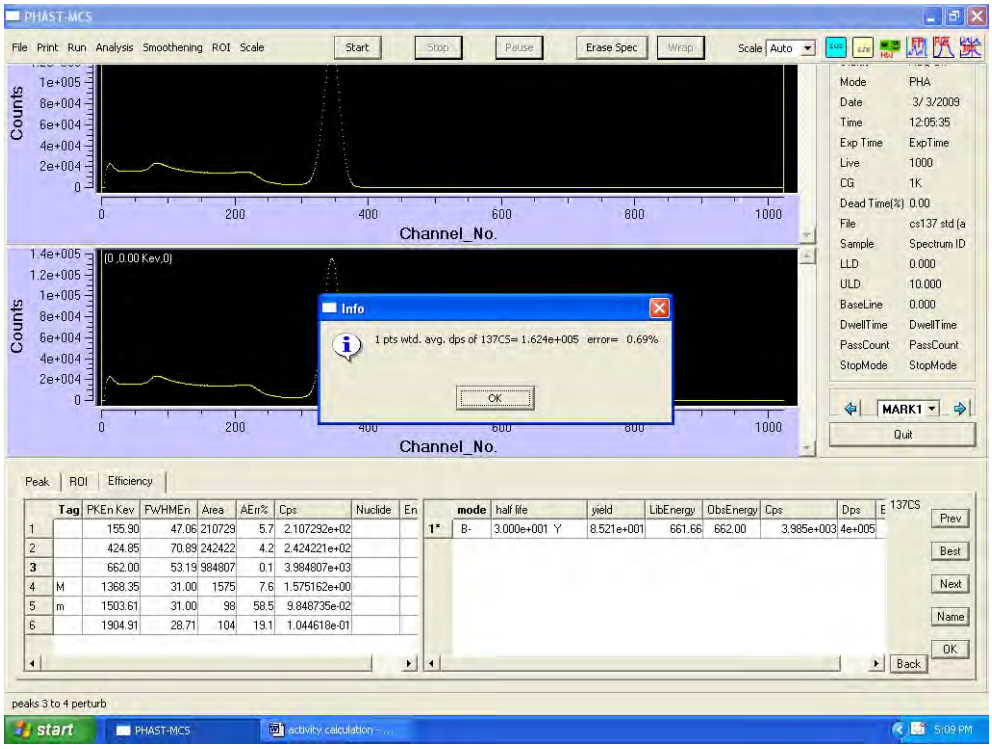
The procedure for nuclide navigation is same as described for efficiency Calibration. Click'**Name**' at the bottom side of right hand side of the above Window.



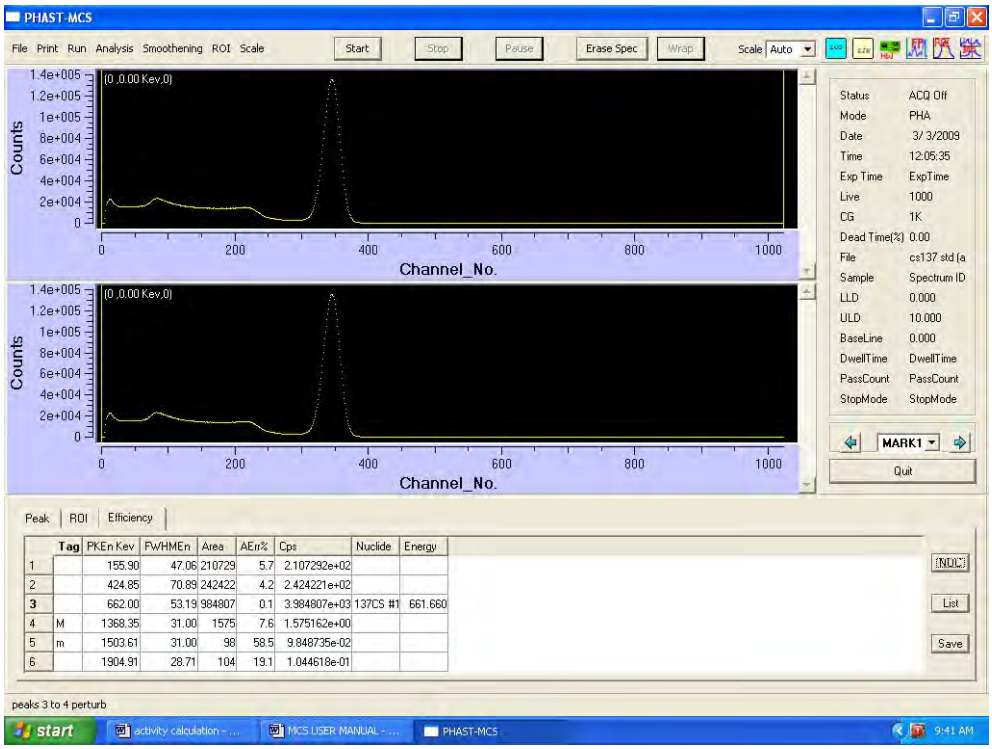
Enter the **nuclide name** and click '**Ok**'



Select the strongest observed line from the library and observe data display and Click'**Ok**'



The popped up window shows the weighted average of dps with error.



By clicking the '**save**' bottom at the right hand side the results can be Stored. This completes activity calculation. The reports can be recalled from the file menu and by selecting reports Option.

CONTACT US FOR AVAILING SERVICES

Postal/Mailing Address (Phone / Fax / Email)

Nucleonix Systems Pvt Ltd.
Plot No. 162 A&B, Phase II, I.D.A.,
Cherlapally, Hyderabad - 500 051, Telangana, India.
Phone: + 91-40-27263701, 040-27262146, 68888777
Mobile: 7331104480, 7331104481, 7331104482
Fax : + 91-40 - 27262146
Email : info@nucleonix.com

For any information, Contact by email is always appreciated.
(This will help us to respond to you quickly)

Marketing Department :

a) Sales / Commercial Information / Field installation and servicing

For any Commercial, Price information, Product information, customer coordination & quotation
of our products customer related commercial services, please contact front office marketing
staff through the listed Email Ids or Phone Nos. given below

Whom to Contact: Business Executives:	Contact Numbers	Contact by E-mail ID
1. R.Maniram (Sr. Business Executive)	Mob:7331104481, Ph-040-27263701	info@nucleonix.com
2. Ch.Gayatri (Business Executive)	Mob:7331104481, Ph-040-27263701	info@nucleonix.com
3. K.Swapna (Business Executive)	Mob:7331104481, Ph-040-27263701	info@nucleonix.com

Note: Our business executives will also connect you to concerned Engineer or General Manager for any technical clarifications if required

b) Factory Services
For **Servicing and Calibration** factory services & follow up on the above jobs including dispatch related/payment related issues of serviced & calibrated items please contact

Ms. K.Sarika **Mob:7331104482** **E-mail: info@nucleonix.com**
(Executive services)

She will also connect you to concerned engineer or general manager if required, for any clarifications & deficiencies in services

---

c) Dispatch Related Issues (Production Items)
For dispatch related issues of your ordered equipments, including delays, purchase order related document deficiencies, payment proofs, dispatch docket details and bills etc,.contact

Ms.V.Anusha / Renuka Devi **Ph:040-27263701, Ex-26** **Email: info@nucleonix.com**
(Executive Dispatch)

---

d) Product Technical Information / Clarifications

Whom To Contact:

Contact any front office "Business Executive"- He/She will take your details and connect you to concerned product engineer for any technical clarifications. Best thing is to email your technical queries and obtain the reply, rather than on telephone.

You can also contact General Manager or Director (Tech) if required.

e) Marketing Manager
On business matters for all your marketing services / techno commercial requirements about Nucleonix Products contact:

Bhaskara I.V.
Mob:8019662500
Land lines : 91-40-27263701, 91-40-68888777
Email: info@nucleonix.com

f) General Manager
Dr.M.S.R.Murthy PhD (Nuclear physics)
Land line: 91-40-27263701, 91-40-68888777
Email: info@nucleonix.com

Contact General Manager for all sales / servicing and technical information including customer support related issues, on the delays, gaps & lapses by our staff. Contact G.M. regarding field installations & field servicing jobs schedule etc.

---

g) H.R -Incharge
Contact her regarding, job vacancies, sending resume for employment, H.R. related issues etc. contact

T. SURESH BABU **Mob:7331104480** **Email: recruit@nucleonix.com**

---

h) Director -Technical
Mr. J. Dheeraj Reddy
Email: jdreddy@nucleonix.com
Mobile No. +91-7674009005

Contact him for, any Technical Information and clarifications on products, which cannot be answered by General Manager / Customer support executives.

For any technical deficiencies in products, related issues & suggestions on product improvements you may contact by email or telephone. This will help the company to improve the product & serve you better.

Dealer's complaints, on commercials, lapses by our commercial staff, or any other discripancy, or you like to give any feedback on any Nucleonix staff doing any wrong thing against cleaner / ethical business principles / practices can be complained to any of the directors or managing director.

---

i) Director - IT
Mr. J. Nishanth Reddy
Email: nishureddy@yahoo.com; info@nucleonix.com
Mobile No. +91-9966691000

For any deficiencies in product software's, related issues, & any suggestions or improvisations in software's can be contact by email or telephone. This will help the company to improve the product & serve you better.

---

j) Managing Director
Shri. J.Narender Reddy (Managing Director)
Email : jnreddy@nucleonix.com; info@nucleonix.com

Contact Managing Director for, Foreign relations, International Business co-operation, Joint ventures, Exports, Dealership in other countries, Policy matters, Technology tie-ups etc.

k) Dealers Complaints :
Dealers complaints, on commercials, lapses by our commercial staff, or any other discripancy, or you like to give any feedback on any Nucleonix staff doing any wrong thing against cleaner / ethical business principles / practices can be complained to any of the directors or managing director.

An innovative company working towards excellence in the field of Nuclear Instrumentation

NUCLEONIX SYSTEMS PVT. LTD.

Plot No.162 A & B, Phase-II, IDA, Cherlapally, Hyderabad-500051 INDIA.
Ph: 91-40-27263701, 040-27262146, 68888777, Fax: 040-27262146

E-mail: info@nucleonix.com website: www.nucleonix.com