GR-130/GR-320

EXPLORE-4 Software

Users Manual

Software Version 5.2 (or later)

August 3, 2000

Part#92435-2 Rev.1.0

EXPLORANIUM

RADIATION DETECTION SYSTEMS

EXPLORE-4

Spectrometer Software Support Program
Version 5.2 (or later)

For GR-130/GR320
Spectrometer Systems

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For GR-130/GR-320
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1.0 GENERAL OVERVIEW

EXPLORE-4 is a Microsoft Windows compatible software package designed to enable the user to easily retrieve stored data from the GR-130/GR-320 into a computer and perform some basic data analysis.

EXPLORE-4 has the ability to export and plot individual spectrum, compare 2 spectrum, plot many spectra using 3-D Show or compare using 3-D noise-adjusted differential Show, plot and export a summed series of spectrum, export each spectrum record as a file, export multiple spectrum records as columns in one file, or calculate counts and concentrations in the IAEA recommended Region-of-Interests (ROI's) from the spectrum data.

ROI data can be stored in an ASCII file containing other useful information including livetime and GPS/location data. This ROI file can be viewed and plotted from within the program or imported into any spreadsheet package for specialised analysis.

In addition, a calibration of the GR-130/GR-320 can be carried out. This requires a set of test pads with known concentrations of Potassium, Uranium and Thorium (see Appendix B - Test Pad Procedures for more information).

NOTE: THIS SOFTWARE VERSION IS FOR USE WITH GR-320 SYSTEMS HAVING SOFTWARE VERSION 3.0 OR LATER AND GR-130 SYSTEMS HAVING SOFTWARE VERSION 4V03 OR LATER.

2.0 SYSTEM REQUIREMENTS

The software is designed to run under Microsoft Windows 95, Windows 98 or Windows NT 4.0. Install the EXPLORE-4 program by inserting the disk labelled EXPLORE-4 Disk 1 and running Setup.exe. The program will ask whether to install to the default directory "EX4" or to a different directory. Click Finish to install the program; during installation the user is prompted to insert EXPLORE Disk 2, 3.

The following files will be installed in the selected sub-directory:

IW_EN.LRM	
EXPLORE4.EXE	Explore Program
DEFAULT.CAL	Calibration file data for the Pads that Exploranium uses for system Calibration. If the user wants to carry out calibration on their own pads the appropriate data must be entered. We recommend that this file is copied under a new name (say USER.CAL) and then edited to the correct information using a simple, Text editor - ensure that the data stays only as an ASCII file with no embedded word-processing characters.
SERPDRV	Serial port driver
UNINST.EXE	Uninstall program

Additional Test data files are also included to permit the user to practice data processing.

C:\DAT\TEST.DAT	10 Spectrum files from the GR-320

The software will create an Icon labelled "EXPLORE4" in a window labelled C:\EX4. A "double-click" on the icon will start the program or move it to the desktop to create a shortcut.

TIP: If there are problems during installation or during data-transfer and a laptop computer is being used, the problem may be due to interference between the internal Power management software and the RS-232 port. Also, if the laptop has an IR port it may have to be disabled.

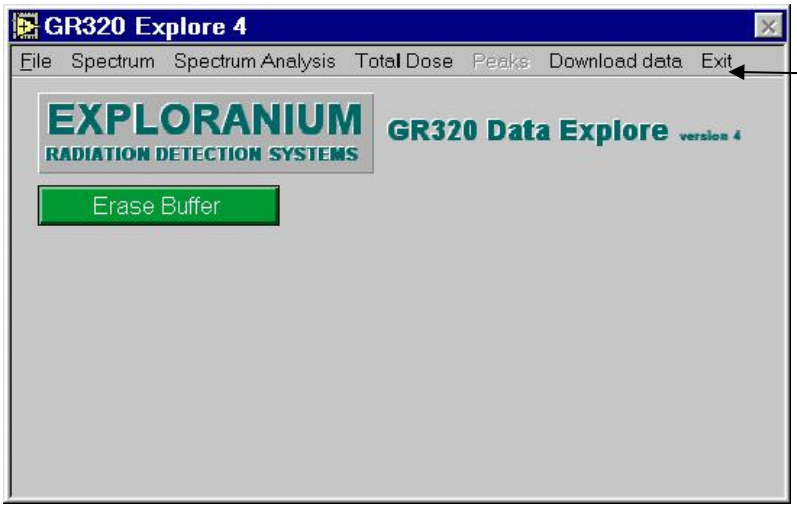
If only one COM port is available and is shared with a modem there may be some difficulty downloading data.

The most common problem is improper COM port selection. If there is only one port it does not automatically get assigned COM 1. Check the Windows Control Panel – System – Devices – Ports for a list of all port numbers available then try each one until the data connection is made.

If still experiencing problems contact Exploranium.

3.0 RUNNING THE PROGRAM

When the EXPLORE4 Icon is "double-clicked" the following screen appears



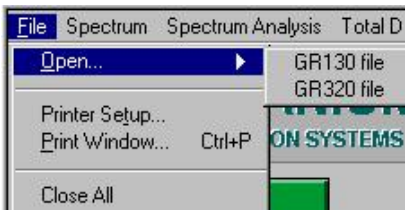
User can select from the drop-down menus to retrieve stored data or download data from the GR-130/GR-320 on the RS-232 port.

The various functions are :

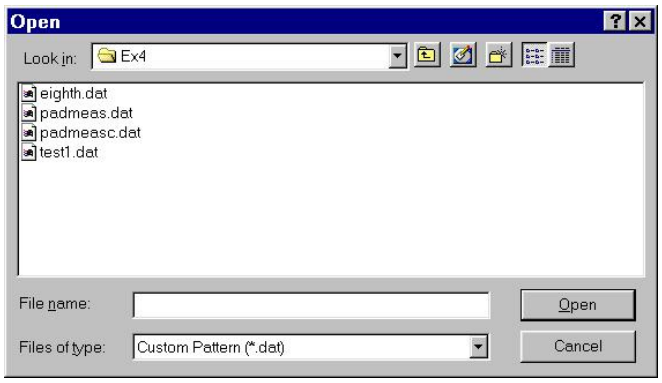
File :	Data selection and some Print utilities (see Section 5)
Spectrum :	Stores data spectra viewing options (see Section 6)
Spectrum Analysis :	Stored spectra data analysis (see Section 7)
Total Dose :	Total Dose Rate computation (see Section 8)
ROI :	Export ROI data (see Section 9)
Download data :	Download data from the GR-130/GR320 to the PC (see Section 4)
Exit :	Exit the program

4.0 File - selection

This option is used to review data previously downloaded and saved to disk.



User must select File – Open – GR-130/320 file to use an existing data file.

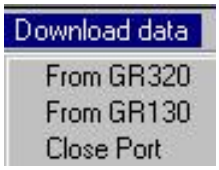


The Open File dialog box appears, allowing the user to select a *.dat file for analysis of stored spectra data.

Once the file has been selected, a box appears stating that the file has been loaded along with the number of records the file contains. The user can now view the spectrum (see Section 6.1).

NOTE: If the stored data changes format in the middle of the file, the program will indicate a checksum error and ask for retry. The YES retry option will continue using the new configuration. The CANCEL option will terminate the conversion/reading at that record.

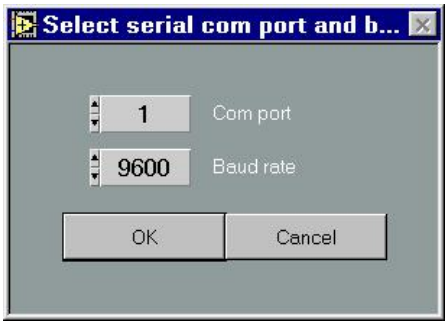
5.0 Download data selection



This will download and save data from the GR-130 or GR-320 via the RS-232 serial port.

The user selects Download Data – From GR-320/GR-130 Port to open a COM port and begin downloading data.

User must select :



Com port - 1 (1-9) select as required

Com port is the port the computer is connected to. The cyclic arrows are used to change the Baud rate. If there are problems try selecting another port; the program will advise you if the port does not exist or cannot be accessed.
Note: The Data bits, stop bits and flow control are set up by this program - the Windows Control Panel Serial Port properties have no influence.

Baud rate - 19200 (9600, 19200)

Baud rate is the data transfer rate. For maximum data transfer speeds 19200 is recommended if the PC can accept this data rate)

At this point the user must adjust the appropriate RS-232 settings on the GR-320 to match the selected data transfer settings. Once the GR-320 is set up to match the users requirements then it stays in this format so these adjustments do not have to be repeated.

For GR-130: MAIN MENU DATA MEMORY DUMP (press button down) or change the Setup Menu

ANALYSIS Sampling = Rep-PC

On the GR-320 :

- Start at MAIN MENU
- Press "6" to select data Output menu
- Press "SHIFT" to set 'Device = RS-232 SIMPLE'
- Arrow down to elect Bd rate
- Press "SHIFT" to set to 19200
- Press "ENTER" to accept these changes

(The Baud rate will stay set at 19200 until it is changed, even after the power has been switched off, or if Menu 6 data output is changed to Data Memory or None.)

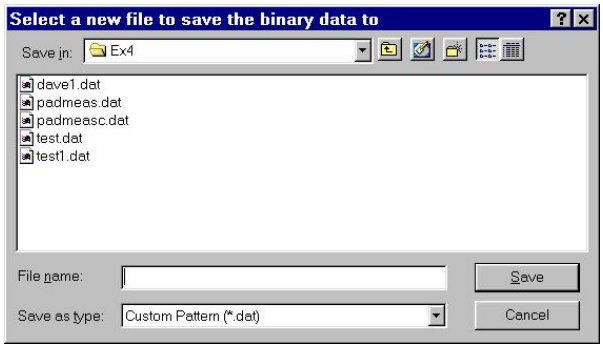
Once the GR-320 is set correctly, select as follows :

CANCEL - will close the port and return to the

previous screen

OK - starts the download process

When OK is selected, a dialog box appears prompting the user to select a file to save the binary data to.



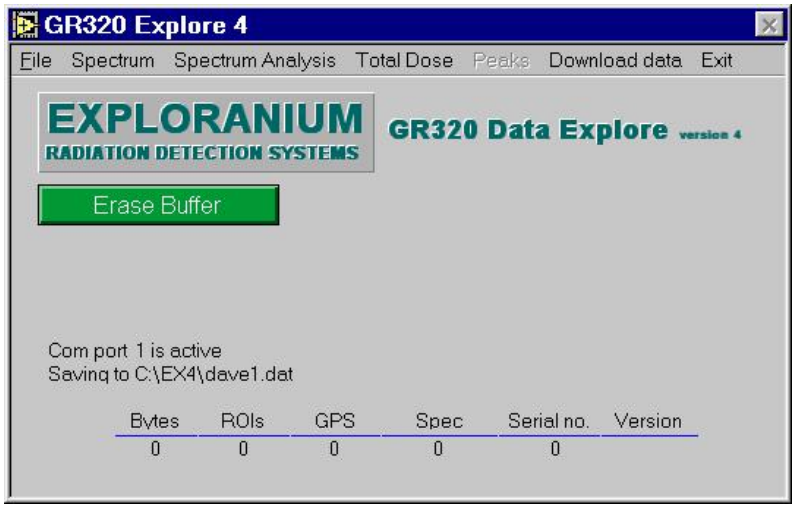
The use may store new data in a new data file (NEW) or append new data to an old data file (APPEND)

NEW – type in a new file name (system will add '.dat' as it's extension

APPEND - select an existing '.dat' file name

Cancel – will cancel data output and return to the previous screen

SAVE - The system is ready to accept data from the GR-130/GR-320 and the following screen appears.



There are 2 choices for downloading data – MEMORY or REAL-TIME

a) MEMORY – this is the normal method of data download. In this case the user has stored a variety of data in the GR-320 memory and requires downloading this data into the specified data file.

Press : Erase Buffer

To remove any old data from the memory buffer

On the GR-320 from the MAIN MENU, press "8" (to select menu 8 = data memory) then "2" to download the data (approx. 1 spectra per second).

b) REAL-TIME - in some cases the user may want to log spectral data as it is recorded by the GR-320 so at the end of each spectra sample the spectral data must be downloaded to the PC for

data storage. This method is used when long term data acquisition is required as the GR-320 can only record typically 600 spectra in memory.
Press : 

To remove any old data from the memory buffer

On the GR-320 from the MAIN MENU press "START" to start the data storage process.

In this case data acquisition will continue until the user pressed "STOP" on the GR-320.

All screens are operational while the program is accepting data from the GR-320; however some will update as data comes in while others will only take a "snapshot" of the current data.
(REMOTE has been omitted to remain backwards compatible but will be available with Firmware Versions 4.5 and higher).

The display will show categories of data received.

Bytes: Number of bytes in the serial buffer. Normally this number starts at 0 and increases until it equals the record length (typically 622 for ROI's and Spec 256)

ROI's: Total number of ROI's collected.

GPS: Includes Keyboard entered and AUTO position in addition to GPS – if these parameters are selected on the GR-320 the data will show under this category. The GPS data will be saved with the ASCII data inside "Spectrum Analysis Calculate" (see Section 6.0).

Spec: Total number of spec resolved. If there are 2 detectors and 2 spectrum are being output, this number will increase by 2 for each record (Menu 3 and Menu 6 on GR-320).

Serial no: the GR-130/320 Serial Number.

Version: the GR-130/320 software version.

NOTE: The ROI block will be downloaded and saved but not used inside this program. All ROI's will be recalculated inside this program unless the data downloaded is ROI only.

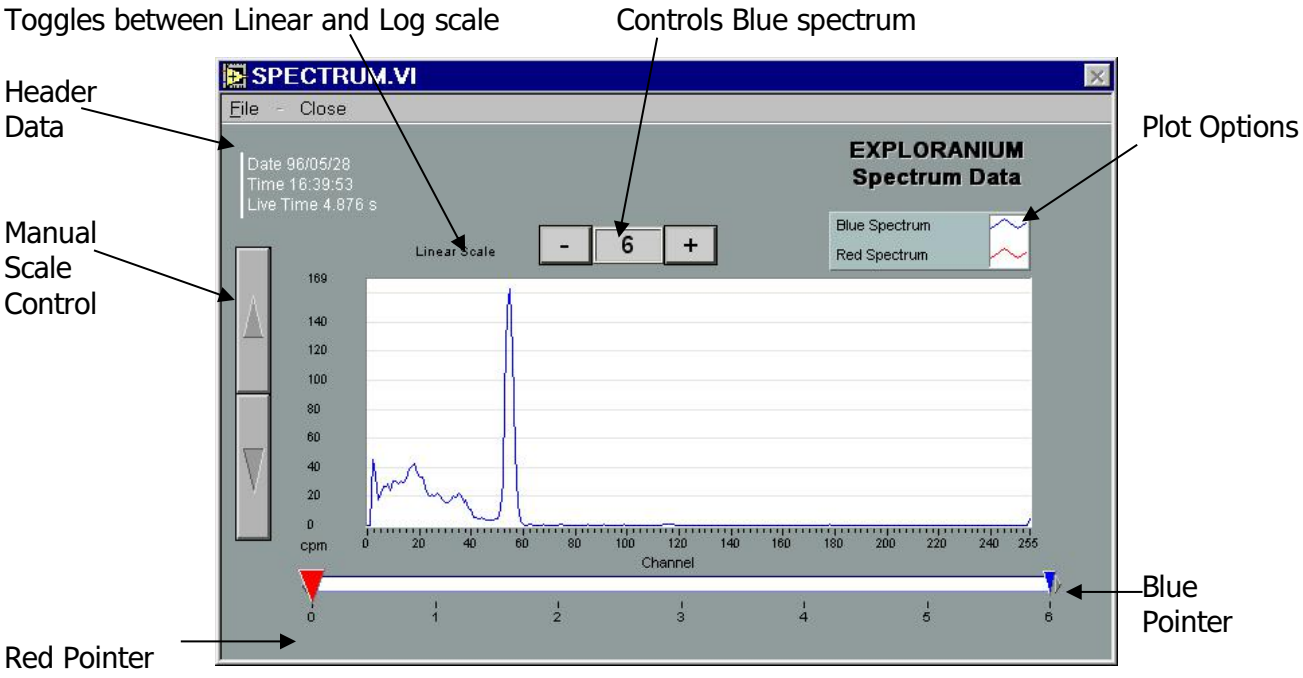
6.0 SPECTRUM selection

6.1 View Spectra

This selection lets the user display and view stored spectra in memory. To view data:

- File – Open – GR-130 file, GR320 file
- Select a file from the display list
- Select OPEN

The following screen appears



The Blue spectrum may be controlled by the plus/minus buttons or by the blue pointer below the spectrum. The Red spectrum is controlled only by the Red pointer.

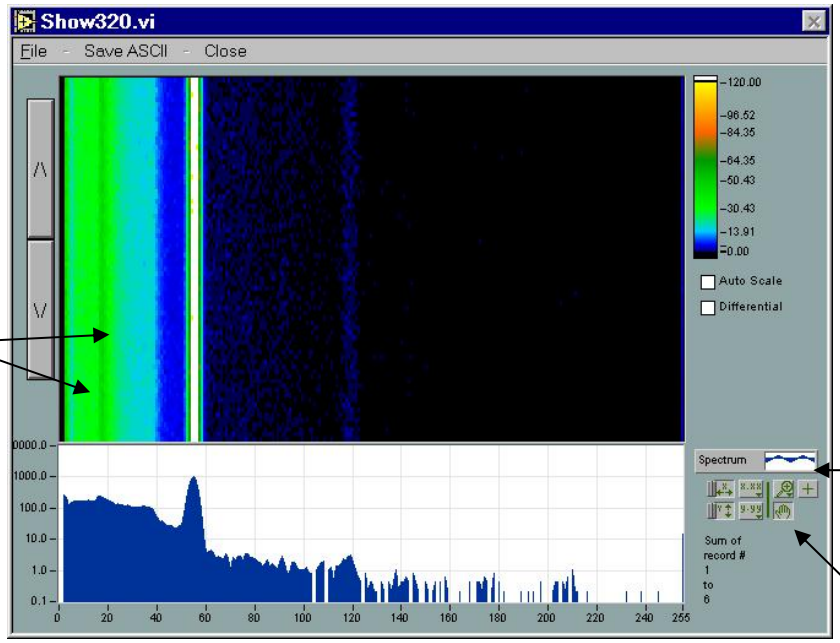
The Blue spectrum is always active, while the Red spectrum may be "parked" at the 0th record and therefore not displayed.

There are many display options common to all plots – see Appendix D for details.

To bring up the cursor display right-click inside the spectrum pane and select "SHOW" then – "CURSOR Display". More information on the cursor options is available in Appendix D.

6.2 View Show

Selecting View Show under the Spectrum menu brings up the Show display. The Show display is a 3D history of the spectrums. The x axis is Energy (channel) increasing left to right. The y axis is time elapsed, newer top to bottom. The z axis is Live-time correct count intensity, defined by the colour ramp.



Clicking in this area displays the spectrum below

see Appendix D

define

Click once to the starting point and click with the SHIFT key pressed to define the end point. The resulting summed spectrum between the 2 points will be displayed.

Auto Scale – Toggles the autoscale feature (z axis)

Differential – Will show the noise adjusted difference between each 2 adjacent spectrum.

Save ASCII

Will save only the current spectrum or summed spectrum as shown in the spectrum window. The file will be saved as the normal *.ASP type (see Appendix A)

6.1 Save ASCII selection

This selection is for saving the data as an ASCII file. When Save ASCII is pressed a dialog box appears, prompting the user to Choose file to write. An existing file can be used or a new file can be created by typing in a filename in the space provided. Once Save is pressed the data is saved to the ASCII file.

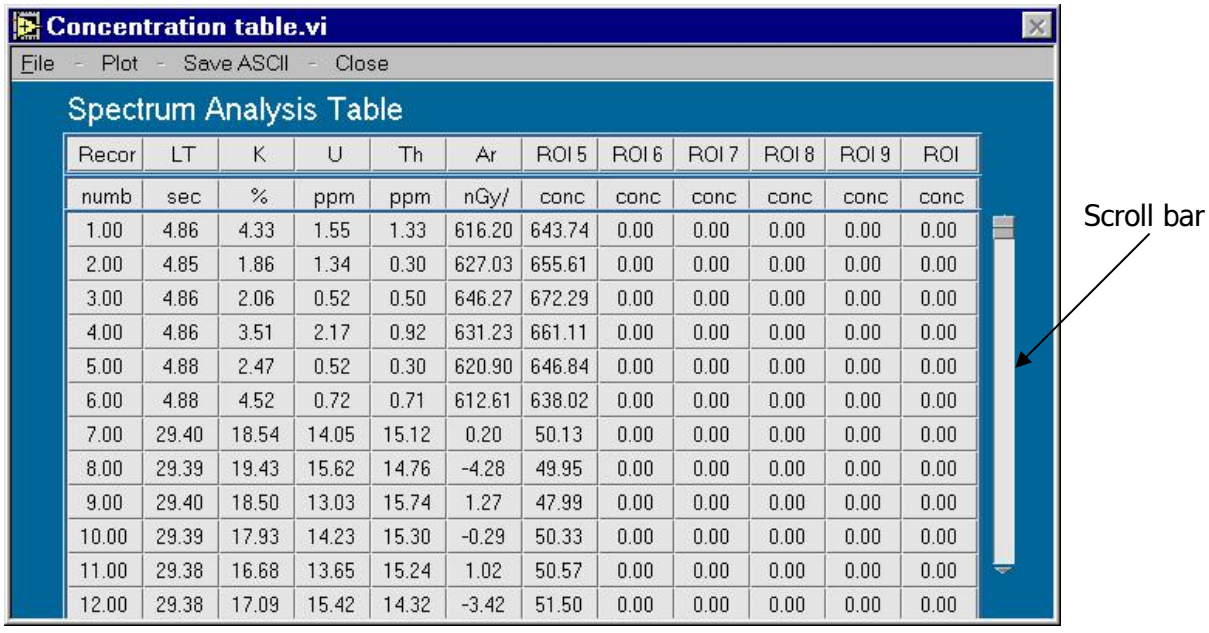
7.0 Spectrum Analysis selection

This selection permits the user to process spectrometer data stored in the memory of the PC. This program can only be used if full spectrum data has been recorded. The program uses the ROI channel limits defined in the selected calibration file and extracts the actual ROI count data from the spectra as well as some other data from the data block header. The cal file is a text file that is unique for each GR-320-GPX 21 or GR-130 (see Appendix A).

ROIs only Data
Users that have only ROI data can also process data using Spectrum Analysis. The user has to take care to ensure that the ROI windows in the 320 match those in the cal file. The order is slightly different between the GR-320 ROIs and the cal files' ROIs – the GR-320 has Total Count, K, U and Th while the typical cal file has K, U, and Th with no Total Count. When the analysis is started, the program first checks for spectrum data. If no spectrum is found it will use the ROI data. If ROI data is used the first ROI (Total Count) is moved from ROI#1 to ROI#10 and the following ROIs are shifted down.

7.1 Calculate

Once Spectrum Analysis – Calculate is selected, an open file dialog box is displayed prompting the user to select a calibration file (*.cal). These *.cal files are CALIBRATION files that contain data analysis parameters derived from a system calibration on special Test pads. If the user has access to these pads then they can create a new Calibration file as described below – most users should select DEFAULT.CAL as the processing Calibration file to be used. After selecting the Calibration file the following table is displayed:



Recor	LT	K	U	Th	Ar	ROI 5	ROI 6	ROI 7	ROI 8	ROI 9	ROI
numb	sec	%	ppm	ppm	nGy/	conc	conc	conc	conc	conc	conc
1.00	4.86	4.33	1.55	1.33	616.20	643.74	0.00	0.00	0.00	0.00	0.00
2.00	4.85	1.86	1.34	0.30	627.03	655.61	0.00	0.00	0.00	0.00	0.00
3.00	4.86	2.06	0.52	0.50	646.27	672.29	0.00	0.00	0.00	0.00	0.00
4.00	4.86	3.51	2.17	0.92	631.23	661.11	0.00	0.00	0.00	0.00	0.00
5.00	4.88	2.47	0.52	0.30	620.90	646.84	0.00	0.00	0.00	0.00	0.00
6.00	4.88	4.52	0.72	0.71	612.61	638.02	0.00	0.00	0.00	0.00	0.00
7.00	29.40	18.54	14.05	15.12	0.20	50.13	0.00	0.00	0.00	0.00	0.00
8.00	29.39	19.43	15.62	14.76	-4.28	49.95	0.00	0.00	0.00	0.00	0.00
9.00	29.40	18.50	13.03	15.74	1.27	47.99	0.00	0.00	0.00	0.00	0.00
10.00	29.39	17.93	14.23	15.30	-0.29	50.33	0.00	0.00	0.00	0.00	0.00
11.00	29.38	16.68	13.65	15.24	1.02	50.57	0.00	0.00	0.00	0.00	0.00
12.00	29.38	17.09	15.42	14.32	-3.42	51.50	0.00	0.00	0.00	0.00	0.00

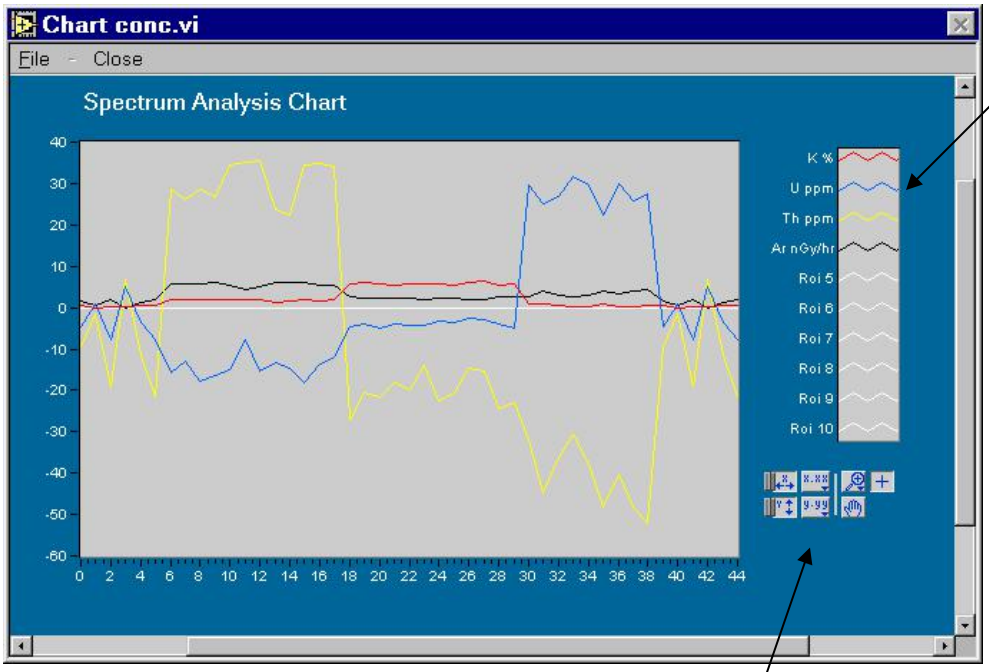
The table shows the results of processing the selected spectra data file with the selected Calibration file.

If GPS or Auto position data has been saved with the spectrum it will be exported to the ASCII text file when using the "Save ASCII" option.

Plot Opens a new window that plots the results graphically (see Section 7.2)

7.1.1 Plot

This permits the user to see the results from the data processed - in this case the 10 ROIs. The range of K, U, Th data can be seen. This data can be printed on the printer as required by selecting File Print Window.



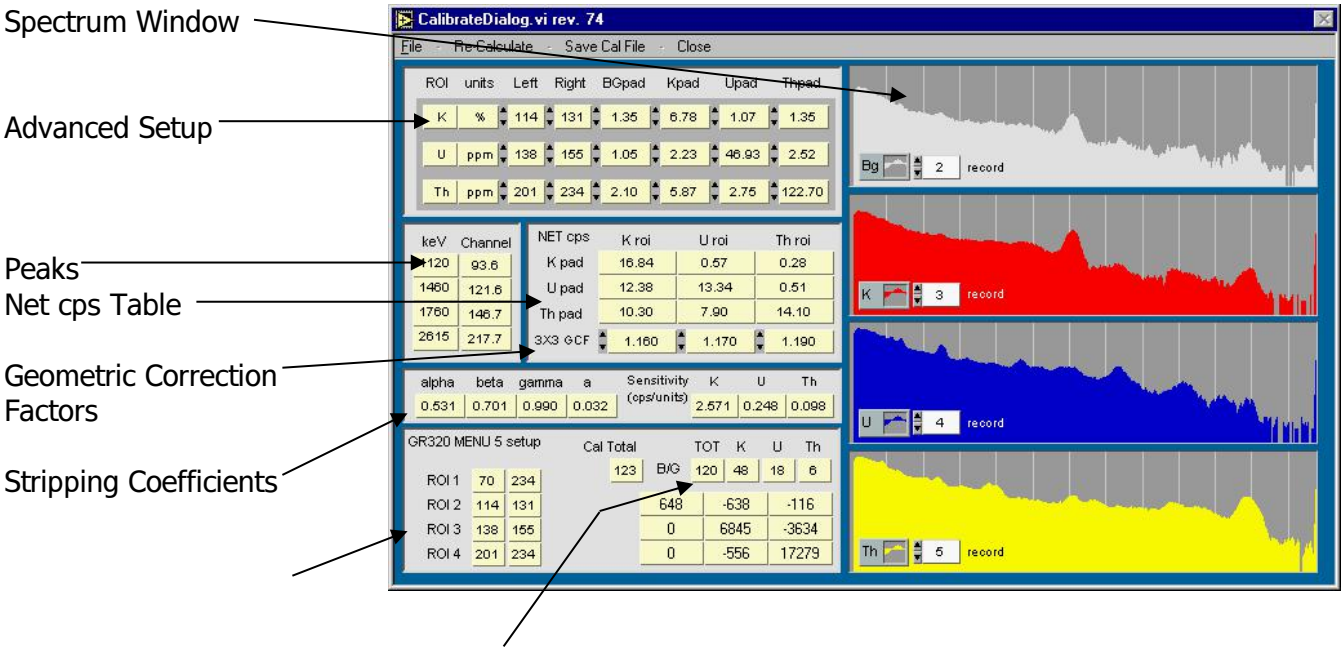
7.2 CALIBRATE

Selections under "Calibrate" permit the user to calibrate the spectrometer system but require access to a set of Calibration Test Pads. Some Pads are available in various countries as permanent installations but increasingly the use of "Portable Calibration Pads" is becoming widespread. Such Pads are 1m x 1m x 0.3m in size and weigh typically 700 KGs each - a set of 4 pads are required - BLANK, Potassium, Uranium and Thorium. Users interested in purchasing such pads can contact Exploranium.

Note: Calibration data in the defaults.cal file is only the average of a variety of GR-320 data sets. Users who do not intend to use the test pads themselves must use the calibration selection to process the cal file from their own systems (obtained from Exploranium if not included with the shipment).
Check: If there is a "cal" file on the installation disk labelled "ser#.cal" (where ser# is the serial number of your GR-320 unit) then this is the correct cal file. If this file is missing please contact Exploranium.

Pad Calibration Procedure

Spectrum Analysis => Calibrate => Pad Calibration brings up the following screen:



GR-320 Menu 5 Setup

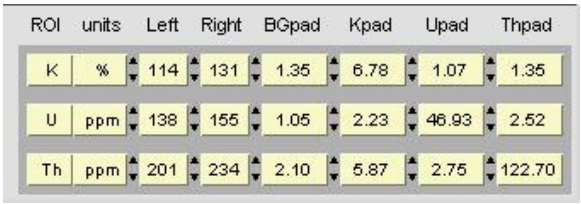
GR-130 values will be different due to
the size difference between the detectors

The pad cal feature allows the user to re-evaluate the stripping coefficients and sensitivities for their GR-130/GR320. This can be done from an existing file or directly from a GR-130/GR-320 download. For a complete pad data collection procedure refer to the full pad calibration description in Appendix B. After collecting and downloading the data to the EX4 program, start the Pad Calibrate and select the appropriate index for each of the pad records. The user must modify the default pad concentration values to match those of their pads. If the pad data collected at Exploranium is being used, the default values are the correct ones. The default spectrum order is BG, K, U and Th pads; if this is not the order the data was

collected in or the pad data is not the first of the records in memory the record number in each of the appropriate pad / spectrum windows must be adjusted. Each time any record number is changed the calibration is recalculated and the results will be updated.

NOTE: For GR-130 users the Geometric Correction factors should be changed to 1.08.

Advanced setup

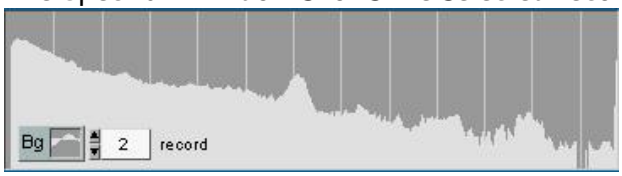


ROI	units	Left	Right	BGpad	Kpad	Upad	Thpad
K	%	114	131	1.35	6.78	1.07	1.35
U	ppm	138	155	1.05	2.23	46.93	2.52
Th	ppm	201	234	2.10	5.87	2.75	122.70

ROI left and right are calculated from the peak values found and with their gamma line energies a quadratic equation is fit to the channel energy relation. From this quadratic the new windows are selected using the IAEA ROI window standard energies. The program allows the user to "override" some of the choices to customise their calibration. The items with the up/down arrows beside them may be modified. For example if you would like to modify the ROI windows you can override the settings calculated by highlighting the appropriate box Left and Right. The RE-CALC menu item must now be selected to process the current settings. Note: if you were to change any of the spectrum record numbers the peak search ROI setup would be redone automatically and any window changes you have made would be overwritten.

Spectrum Window

The Spectrum window shows the selected record for each of the 4 pads labelled BG for background, K for Potassium, U for Uranium and Th for Thorium. To select another record index change the number in the box labelled "record". This display is a good tool to confirm that the chosen record is the correct one and that the peaks line up with each other. Each of the spectrum displays has the same customising menus as all other graphic charts (see Appendix D).

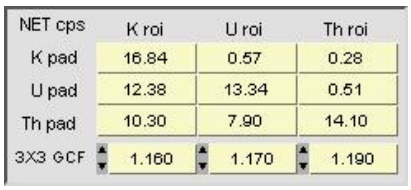


Peaks

keV	Channel
1120	93.6
1460	121.6
1760	146.7
2615	217.7

The peaks routine operates only after a record index has been changed or during the first execution of the pad cal routine. The program gets the 1120kev gamma ray line from the Uranium pad data, the 1460keV from the Potassium pad, the 1760keV from the Uranium pad and the 2615keV from the Thorium pad. If the peaks are placed wrongly the user can manually modify the ROI windows.

Net cps Table



NET cps	K roi	U roi	Th roi
K pad	16.84	0.57	0.28
U pad	12.38	13.34	0.51
Th pad	10.30	7.90	14.10
3X3 GCF	1.160	1.170	1.190

The Net cps table shows the live-time corrected counts minus the cps on the BG pad. This is a good indication that the pad record index order is correct. These are typical values for a GPX21 (3 by 3-inch detector). GCF is the geometric correction factor used for the 1m by 1m-transportable pads. You may change these values to suit your situation. The GR-130 typical values are 1.08.

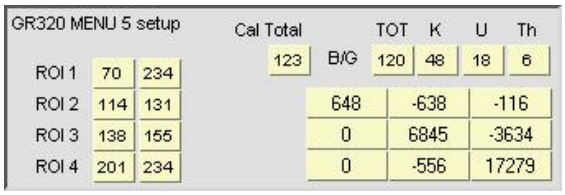
Stripping Coefficients

alpha	beta	gamma	a	Sensitivity (cps/units)	K	U	Th
0.531	0.701	0.990	0.032		2.571	0.248	0.098

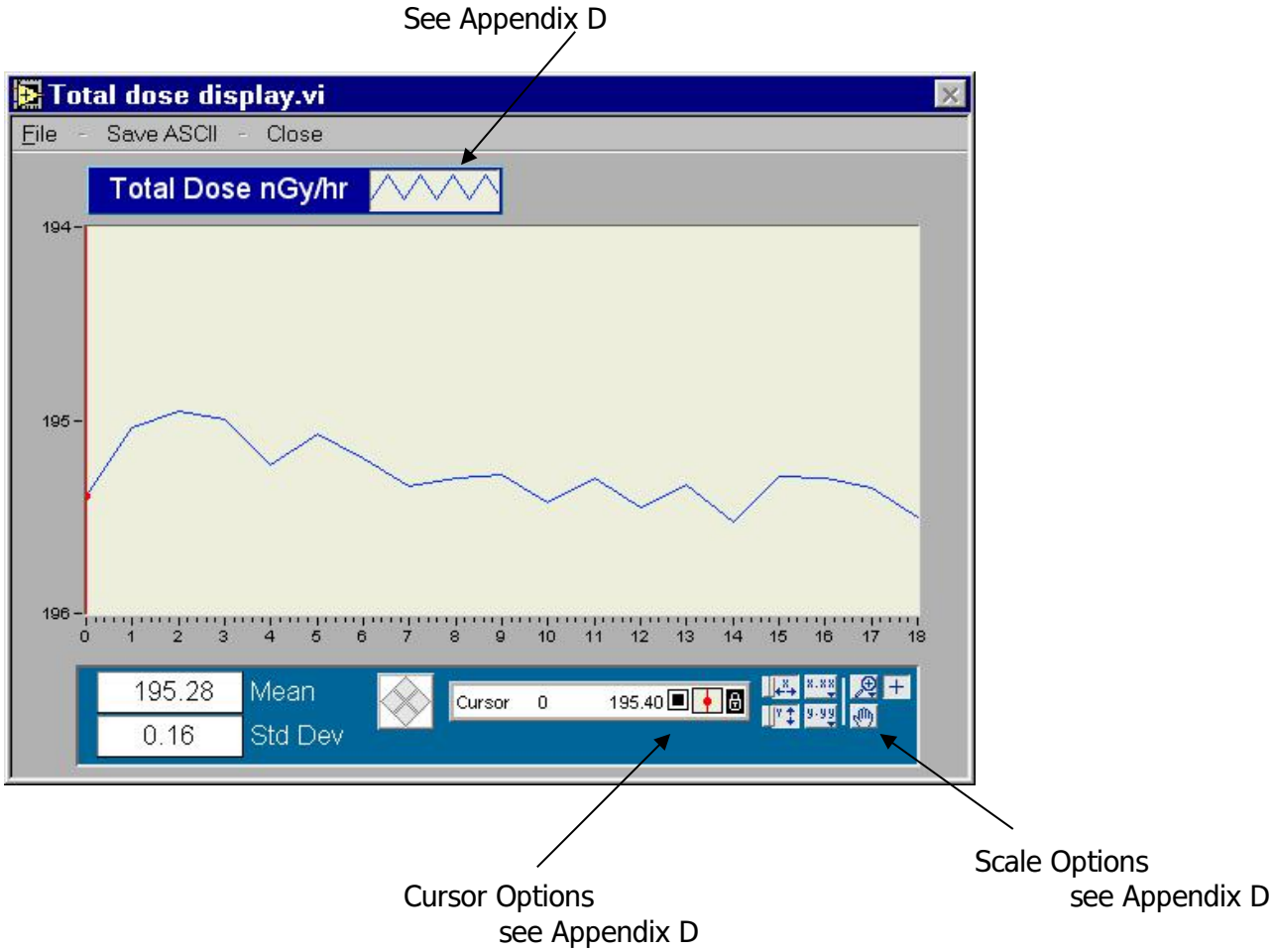
The stripping coefficients are shown here for user confirmation. If the user is familiar with the "alpha", "beta", "gamma", and "a" values they can be compared to the expected values. The sensitivities are geometrically corrected by the GCF values.

GR-320 MENU 5 Setup

The GR320 assay mode requires that ROI #1 is total count #2 is potassium #3 is uranium and #4 thorium. If the pad calibration was done with 512 channel mode the ROIs would be displayed and have to be entered in the 512 channel mode. The GR320 will automatically change the windows when changing back and forth between 512 and 256 channel modes. Cal Total is the equivalent Uranium conversion factor for the total count. The B/ G numbers are the typical background values (cpm) for a 3X3 detector taken over water away from any land or radon effects. The BG numbers must be changed for GR-130 users.



8.0 Total Dose



The total dose has been calibrated on similar units to give an approximation of the semi-infinite air kerma rate. The spectrum is multiplied by weighing factors for each channel, then integrated up minus the background to give an air kerma rate for each spectrum. The dose vector only applies to the 3x3 detector in the GR-130.

Note: the Cs source should be removed to give a proper reading.

Special Note – Removing the Cs Source

This software calculates the semi homogenous kerma rate in air. To get an accurate Dose measurement the 0.25 Ci Cs source should be removed from the end of the detector. When this is done some

changes are required. The MENU 3 stabilisation element should be changed to something other that Cs. Exploranium normally recommends Th (refer to supplied calibration sheet for the proper channel) with a count level of 200 counts (256 channel) and a timeout of 2000 seconds. The GR-320 will automatically adjust the values set when switching from 256 to 512 channel mode. If the system has been idle for more than a few hours it should be tested with Cs. "System Test" is under Menu 1 – press SHIFT to select Cs then press ENTER. After the quick test (10 sec) the System Test can be stopped and the Cs source removed; the system can now be started normally.

APPENDIX A - FILE LISTINGS

A.1 Cal File Layout

The user can edit this file (using a non-formatting text editor such as Notepad or Dos Edit) to change system calibration. Exploranium recommends the user discuss proposed changes with them as significant errors can occur if incorrect data is entered

---

1. ROI 1 Name =K ,K % - "K" = sets the parameter name for ROI#1
   "K%" = sets the units of the data after applying the cal coeff.
   ROI 1 = 114,130 - sets the limits (in channels) of ROI#1
   ROI 1 backgrnd cps = 6.3 data derived from a system calibration
   ROI 1 cosmic cps/cosmic = 0.00 data derived from a system calibration

---

For ROI#2-10 – same explanation as for ROI#1

2. ROI 2 Name =U,U ppm
   ROI 2 = 139,155
   ROI 2 backgrnd cps = 2.2
   ROI 2 cosmic cps/cosmic = 0.00

---

3. ROI 3 Name =Th,Th ppm
   ROI 3 = 201,232
   ROI 3 backgrnd cps = 1.5
   ROI 3 cosmic cps/cosmic = 0.00

---

4. ROI 4 Name =Cs,Cs kBq/m²
   ROI 4 = 50,60
   ROI 4 backgrnd cps = 8
   ROI 4 cosmic cps/cosmic = 0.00

---

5. ROI 5 Name =TC,TC (ltc)
   ROI 5 = 10,232
   ROI 5 backgrnd cps = 12
   ROI 5 cosmic cps/cosmic = 0.0

---

6. ROI 6 Name =ROI 6,conc 6
   ROI 6 = 0,0
   ROI 6 backgrnd cps = 0
   ROI 6 cosmic cps/cosmic = 0.0

---

7. ROI 7 Name =ROI 7,conc 7
   ROI 7 = 0,0
   ROI 7 backgrnd cps = 0
   ROI 7 cosmic cps/cosmic = 0.0

---

8. ROI 8 Name =ROI 8,conc 8
   ROI 8 = 0,0
   ROI 8 backgrnd cps = 0
   ROI 8 cosmic cps/cosmic = 0.0

---

9. ROI 9 Name =ROI 9,conc 9
   ROI 9 = 0,0

ROI 9 backgrnd cps = 0
ROI 9 cosmic cps/cosmic = 0.0

10. ROI 10 Name =Up U,ltc Up U
ROI 10 = 0,0
ROI 10 backgrnd cps = 0
ROI 10 cosmic cps/cosmic = 0.0

11. Cal Matrix =

1.000	0.800	0.408	0.005	0	0	0	0	0	0	0
0.004	1.000	0.247	0.001	0	0	0	0	0	0	0
0.001	0.042	1.000	0.000	0	0	0	0	0	0	0
0.389	3.322	1.876	1	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	0	0
0	0	0	0	0	1	0	0	0	0	0
0	0	0	0	0	0	1	0	0	0	0
0	0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	0	1

End Cal

12. Sens #1 =50.58 = sensitivity in cps/unit for ROI#1 – derived from a calibration
Sens #2 =4.53
Sens #3 =2.24
Sens #4 =5.0
Sens #5 =1
Sens #6 =1
Sens #7 =1
Sens #8 =1
Sens #9 =1
Sens #10 =1

A.2 ASP File Layout

120.89	Channel 0 Live time in seconds
0	Channel 1
5	Channel 2
12	Channel 3
.	.
.	.
.	.
33	Channel 255 (cosmic)

A.3 GR-320 CALIBRATION SHEET - SINGLE DETECTOR

Customer : _____ Tech : _____Cal Date :_____
Console Ser. # : _____ Detector #1 Ser # : _____ Type : _____
Software : ____V____

M1 System Test : Xtal Resolution : _____% Final Gain : _____

M2 Det.Config : Coarse Gain : 0.5 1.0

	Det#1	ON	
	Det#2	ON	OFF
Normal	Add	Coinc	Anticoinc

M3 Operational Mode

Sampling time 60	(or as required)				
Meas mode	Single	Repeat	Base		
Evaluation	None	Assay		enviSpec	User#1
No channel	256	512			
Control	Keyboard	Remote			
Position	None	Keyboard		GPS	AUTO

M4 Gain stabilization :

Gain stab :		ON		Off	
Stab :		Cs		K	Th xx
Stab.channel		55		_____	_____
Count level :		5000		10000	
Timeout		100			

M5 ROIs

1 70	_____	5	blank	
2 _____	_____	6	blank	
3 _____	_____	7	blank	
4 _____	_____	8	blank	

M5 Calibration :

	TOT	K	U	Th
BG:	_____	_____	_____	_____
Cal TOT	_____			
K		_____	_____	_____
U		_____	_____	_____
Th		_____	_____	_____

M6 Data Output

Device OFF	DATA MEMORY		RS-232 SW HSH	RS-232 SIMPLE	
Bd	1200	2400	4800	9600	19200
Config DET#1 only					
DET#1 ROIs only		ROIs+Spectrum		Spectrum only	

M9 Maintenance Real Time Clock - set as required
ADC Offset : _____
Low thresh : 2

APPENDIX B - TEST PAD PROCEDURES

In this section, the recommended procedures for calibrating a portable spectrometer using the transportable pads are described. The main points to consider are:

1) pad location,
2) counting time, and
3) variations in atmospheric background.

The main requirement in selecting a site for calibration is an area of ground that is flat and relatively homogeneous in its radioactivity. To eliminate any cross-talk between pads, they should be placed at least 3 metres apart, centre to centre.

It is important that the background radiation from the area surrounding the pads should be the same for each pad. In fact, because the pads are a good shield to gamma radiation from the ground, only a small fraction of any background radiation will be detected when calibrating. Unless the ground is both variable and high in radioactivity or there are radioactive sources in the field of view of the spectrometer, problems of background variation from the surrounding ground are therefore unlikely. If there is any doubt, the background being detected on each pad can easily be checked by monitoring the three window count rates on the background pad with the background pad placed in the four pad locations.

The concentrations of the pads were determined on dry material. If the pads are left outside, they should be kept covered to prevent changes in their moisture content and associated variations in their gamma-ray flux.

The time spent recording the window count rates on each pad controls the accuracy of the calibration constants. A longer counting time reduces uncertainties in the window count rate which in turn will increase the accuracy of the calibration. For the GR-320 or GR-130 a 10 minute counting time is realistic, providing calibration constants that are sufficiently accurate for all practical purposes. With this counting time, the total number of counts recorded in the potassium window on the potassium pad, the uranium window on the uranium pad, and the thorium window on the thorium pad will have reached approximately 10 000. This will result in uncertainties in the three window sensitivities of approximately one percent. In practice, it is recommended that this 10 minute counting time be subdivided into smaller counting intervals. The repeatability of the individual measurements will help to verify that the instrument is functioning correctly. Five individual counting periods of two minutes each would be suitable; however, the actual counting period will depend on the particular instrument being used.

When calibrating a spectrometer on the pads, it is essential that the atmospheric background component remains constant on all four pads during the time required to perform the calibration. This can best be done by monitoring the uranium window on the blank pad. In most places, this background variation will be insignificant and have little effect on the calibration constants. However, if significant background changes are found to occur, it may be necessary to monitor the background pad routinely, at the beginning and end of the calibration. If the background has changed significantly, the entire calibration must be repeated.

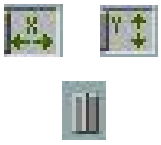
Note: There is a convenient way to load custom pad concentrations. The program will automatically load values from this "pad_conc" file if it is found inside the directory. If the user has their own set of pads, Exploranium can customize this file to match the pad values.

APPENDIX C - FUTURE

APPENDIX D - ICON DESCRIPTIONS

D.1 Palette Options

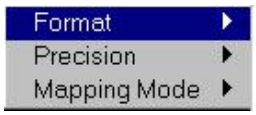
All graphical plots have the scale controls shown on the palette. To show/hide the palette, right-click inside the plot then choose Show - Palette.



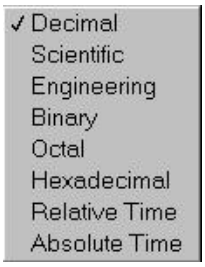
Pressing the *X Autoscale* button (shown left) autoscales the x axis. If the user presses the Y autoscale button (shown right), the graph autoscales the y axis. To autoscale either of the axes continuously, click the lock switch (shown below) to lock Autoscaling On.

The Scale Format buttons maintain run-time control of the format of the x and y scale markers respectively.

Clicking on the arrow at the bottom right of the Scale Format buttons brings up the following selections:



Format:



Precision:

Mapping Mode:

The remaining three buttons are used to control the operation mode for the graph:

The plus (or crosshatch) indicates that the user is in standard operating mode and is used to move the cursor on the display.

The Panning tool switches the user to a mode which allows the scrolling of visible data by clicking and dragging the plot area of the graph.

Pressing the Zoom tool allows the user to zoom in or out on the graph. A pop-up menu will appear in order to choose a method of zooming, which are explained below.

Zoom by rectangle.

Zoom by rectangle, with zooming restricted to x data (the y scale remains unchanged).

Zoom by rectangle, with zooming restricted to y data (the x scale remains unchanged).

Undo last zoom. Resets the graph to its previous setting.

Zoom in about a point. Holding down the mouse on a specific point causes the graph to continuously zoom in until you release the mouse button.

Zoom out about a point. Holding down the mouse on a specific point causes the graph to continuously zoom out until you release the mouse button.

NOTE: For the last two modes, <SHIFT>-clicking zooms in the opposite direction.

D2 Cursor Display

The cursor display is available on all graphical plots. To show/hide the cursor display right-click inside the plot area and select Show Cursor.

The first time the cursor display is brought up it will be empty. Click first on the Cursor Display to start, then the following controls will be active.

Cursor Movement Control. Clicking on the left, right, top or bottom diamond-shaped buttons will move the cursor one point in the corresponding direction on the graph. This is active only when the Select button has been enabled.

Select Button. Allows for use of the Cursor Movement Control when enabled (black square inside).

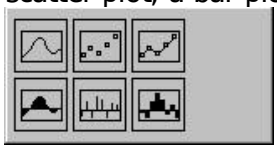
Cursor Display Control. Displays a pop-up menu to control the look of the cursor and visibility of the cursor name on the plot. The illustration below shows this pop-up menu.

The user can use the last button for each cursor to lock a cursor onto a particular plot. Clicking this button enables a pop-up menu to appear with various options as shown.

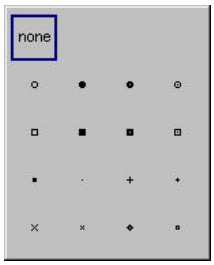
D.3 *LEGEND OPTIONS*

Legend options are shown on all plots. The plot sample pop-up menu is shown in the following illustration. Click inside the legend box for the pop-up menu to appear.

Common Plots item helps the user configure a plot for any of six popular plot styles, including a scatter plot, a bar plot, and a fill-to-zero plot.

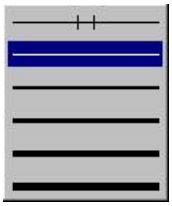


The Point Style, Line Style, and Line Width items display styles the user can use to distinguish a plot from another.



Point Style

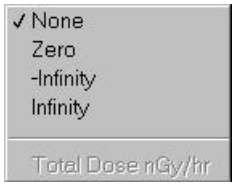
Line Style



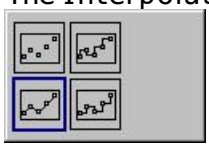
Line Width

The Bar Plots item has a selection of vertical bars, horizontal bars, or no bars at all.

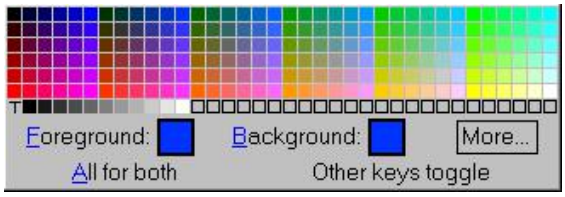
The Fill Baseline item sets what the baseline fills to.



The Interpolation item allows the user to choose how the graph draws lines between plotted points.



The Color item allows the user to customise the foreground and background colors of the plot area and cursor.

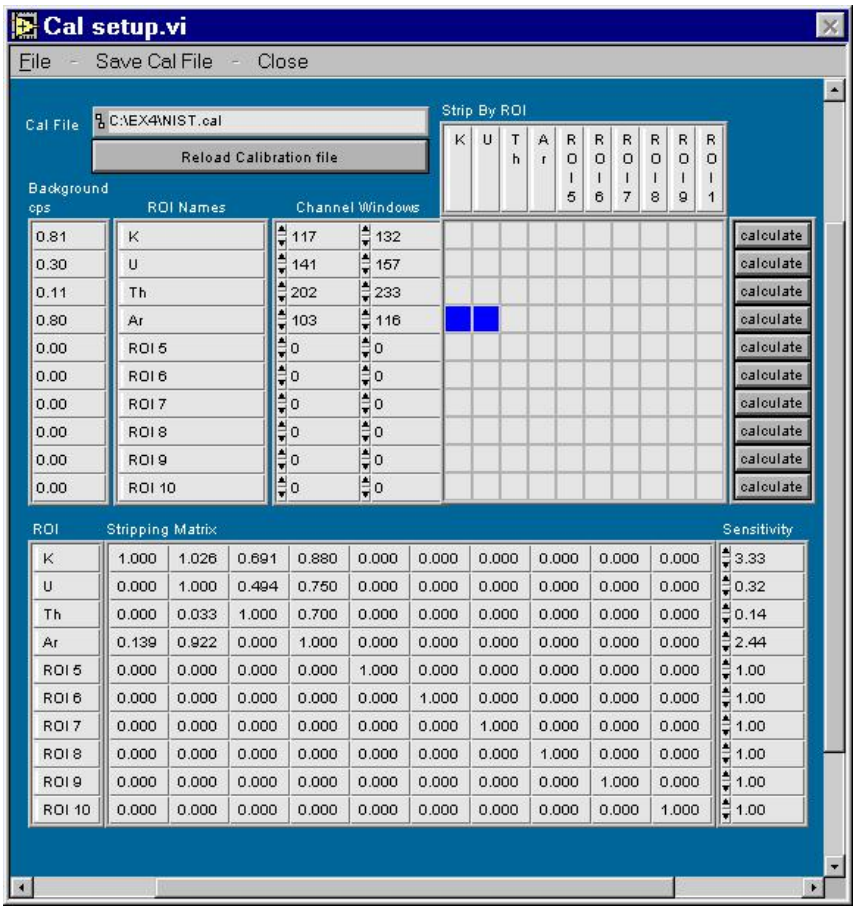


The Y scale item displays a list of the y scales on the graph. This is used on stacked charts to define on which scale each plot is plotted (default set to "(0)").

APPENDIX E - (OPTIONAL) SINGLE ELEMENT STRIPPING

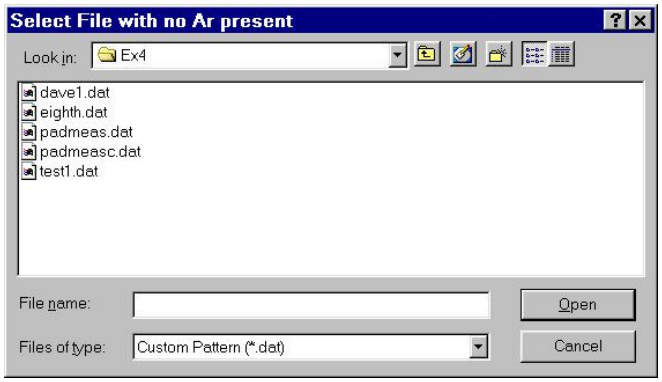
Selections under the "Calibrate Spectrometer" sub-menu "Single Element Stripping" permit the user to calculate the stripping coefficients for a defined ROI window and save those values to the Cal file stripping matrix and background parameters.

After loading a cal file the user can modify the channel windows if required. The 10x10 selection matrix shown below is the default selection and defines what ROI should be stripped by what other ROI's. The default setting will strip K and U from the Ar ROI – or ROI 1 and 2 out of ROI 4. Once the user has selected the ROI's to strip from the proper row, press the appropriate Calculate button at the end of that row.



A dialog box will appear prompting for a data file that is known not to contain any of the elements that

are being stripped.



The program will recalculate the stripping matrix and background values and display the results. The sensitivity can now be changed if desired (the old cal value should be shown).
To save the cal file select from the SAVE TO CAL menu and choose a file; Exploranium recommends choosing a new unique file name.

If CANCEL is clicked then no new cal file will be saved or created. To start again or load a different cal file click the "Reload Calibration File" button. The cal data is formatted and saved to the selected file (see Appendix A for file layout).

APPENDIX F – Troubleshooting

Windows Problems

If the user is utilising the upgrade version of Windows 95 the file MSVCRT.DLL will be missing from the WINDOWS/SYSTEM directory. This file can be copied from another newer version of Windows 95 or contact Microsoft for an update.

DCOM

In alpha or beta versions of Windows 95 the DCOM driver requires updating to the latest version; this driver can be obtained from Microsoft by downloading from the Microsoft web site (www.microsoft.com). The program will run normally without the DCOM update but will have an error message dialog every time the program is launched.

The newer versions of Windows 95, WIN NT 4.0 with Service Pack 3 or Windows 98 have no problems.

APPENDIX G – FAQ

Q – I have downloaded data with GPS info but the ASCII saved data from Spectrum Analysis – Calculate doesn't save any position data to the ASCII file.

A – If the first data record loaded into the buffer doesn't have GPS data then no GPS data will be exported to the ASCII file. Ensure that the first record has GPS data by ERASING the buffer and reloading data containing GPS.

Q – Do I have to calibrate using Pad cal every time I use Explore4?

A – No, the calibration information for each specific GR-320 is saved in a "*.cal" file. This file will be used to process the data and you will be prompted to select a specific cal file. The cal file is a text file that may be modified manually for special applications.

Q – Spectrum Display has a +/- key, a record number and header information; does this work only on the Blue spectrum?

A – Yes, the Red spectrum is only controlled by the red pointer at the bottom of the window.

Q – Why is *Single Element Stripping* greyed out?

A – This is a special environment monitoring feature which will calculate stripping ratios for non-natural radio nuclides. If you are interested contact Exploranium for further information.

Q – My data downloads but I cannot see anything an any of the displays.

Check the baud rate and COM port settings.

Q – I cannot download data to the computer.

A – Check the baud rate on the GR-320 (Menu 6). Try every different COM port number that is available (Check System Devices in Control Panel). Windows 98 can change your port to an unexpected number even if you have only 1 port.

Q – I don't want processed ROI values, just the live time corrected raw counts. How would I achieve this?

A – Modify the cal file in a text editor such as Windows Notepad or Wordpad. Change the sensitivities to =1 to give stripped counts. Change the stripping matrix to a unit matrix to give live time correct and BG subtracted counts. Change the bg values for each ROI to 0 for RAW LT corrected values.

APPENDIX H – AIR KERMA CALIBRATION

CALIBRATION OF THE GR-320 PORTABLE GAMMA RAY SPECTROMETER FOR AIR KERMA RATE

This appendix describes the procedure to calibrate the GR320 portable spectrometer with a 7.6 x 7.6 cm (3 x 3 inch) sodium iodide (NaI) crystal for air kerma rate.

THE GR320 SPECTROMETER

The 7.6 x 7.6 cm (3 x 3 inch) NaI (Tl) detector for the standard GR320 spectrometer is sealed in a cylindrical aluminum housing. The GR320 can record spectral data with 256 or 512 channels but for normal field operation would be operated in the 256-channel mode. The original calibration was done with 512 channels and the thorium peak at 2615 keV (from ^{208}Tl) in channel 436. For normal operation, the GR320 is set-up with the ^{137}Cs peak at 661 keV in channel 55 resulting in the thorium peak being in channel 207 or 208. The calibration has been energy corrected for this typical set-up. If a more accurate air kerma rate were needed there would be a charge for an individual GR320 and crystal re-calibration.

CALIBRATION PROCEDURE

The first stage in the calibration is to relate the spectrum channel number to its energy. At high energies, the sodium iodide detector has a linear relationship between channel number and energy. However, at energies below about 200-300 keV, this linear relationship breaks down. By experiment, a quadratic relationship provides a good approximation between channel number and energy. Ten gamma ray peaks from nine different gamma ray sources were used to establish this quadratic relationship. For the standard GR320 set-up, the quadratic equation relating channel number and energy is given by:

$$*** \quad E(keV) = -15.28 + 11.63 \times Chan + 2.024 \times 10^{-3} \times Chan^2 \qquad (1)$$

The calibration procedure assumes that the air kerma rate, K, from a measured spectrum can be calculated from the energy deposited (E_I) in 10 energy windows (I) using the following equation:

$$K = w_1 E_1 + w_2 E_2 \ldots\ldots\ldots\ldots w_{10} E_{10} \qquad (2)$$

where the ten calibration coefficients (w_I) are constants to be determined.

A total of 10 sources were used to relate the energy deposited in ten selected regions of the spectrum to air kerma. Calibration procedure involved placing the ten sources in a number of different positions around the detector. These measurements were then used to simulate a semi-infinite cloud of radiation.

The measurements were made with the ten sources mounted on the flatbed of a train set with the detector at the center of the circular train track. The sources were then positioned and reading taken at set intervals along the track to simulate the semi-infinite cloud.
The activities of the sources at the time of measurement were calculated from their known half-lives and the date of their certified activity. The gamma ray fluence rate was then determined at the center of the detector, a distance of 60 cm from the source. The air kerma rate in nGy/h was then calculated from this fluence rate using conversion factors interpolated from data presented in the 1995 International Commission on Radiological Protection report ICRP 74.

Source	Energy (keV)
Am-241	60
Cd-109	88
Co-57	125
Ce-139	166
Sr-85	514
Cr-51	320
Cs-137	662
Mn-54	835
Co-60	1253
Y-88	1362

Table 1. Sources used in the calibration

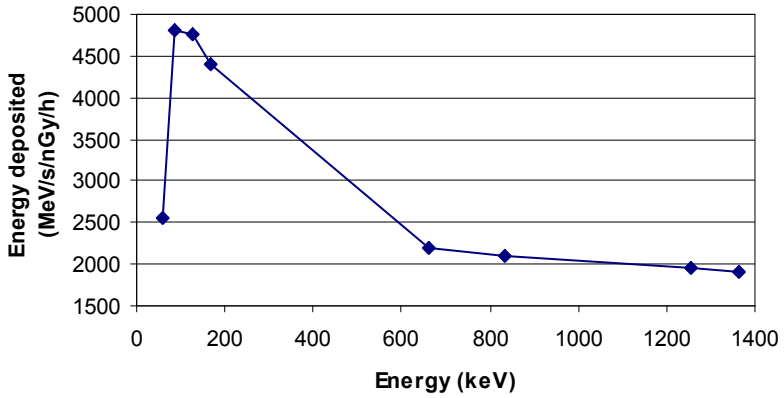


Figure 1. The energy deposited in the GR320 detector with aluminium housing.

Figure 1 shows the calibration factor for the GR320 detector with its aluminum housing. The calibration factor shown in the figure is the ratio of the energy deposited per second in the detector in MeV s^{-1} to the air kerma rate in nGy h^{-1}. In the figure, the calibration factor is plotted against the primary energies of the sources.

The calibration procedure uses a set of ten calibration coefficients to convert the energies deposited in ten regions of the spectrum to air kerma rate. Table 2 and Figure 2 show the calibration coefficients for the ten regions of the spectrum.

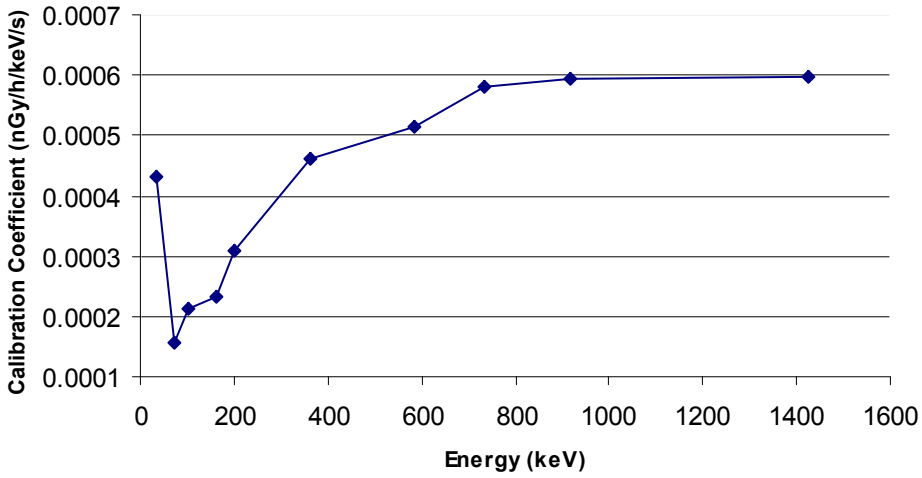


Figure 2. The calibration coefficients to convert the energy deposited in the detector to air kerma rate for

the GR320.

The GR320 software uses a 512-channel vector to convert a measured spectrum to air kerma rate. This vector (shown in Figure 3) has ten regions with the same calibration coefficients as in Table 2. The air kerma rate is then calculated by multiplying this vector with the energy deposited in each channel. This more flexible approach allows for future developments in the calibration procedure.

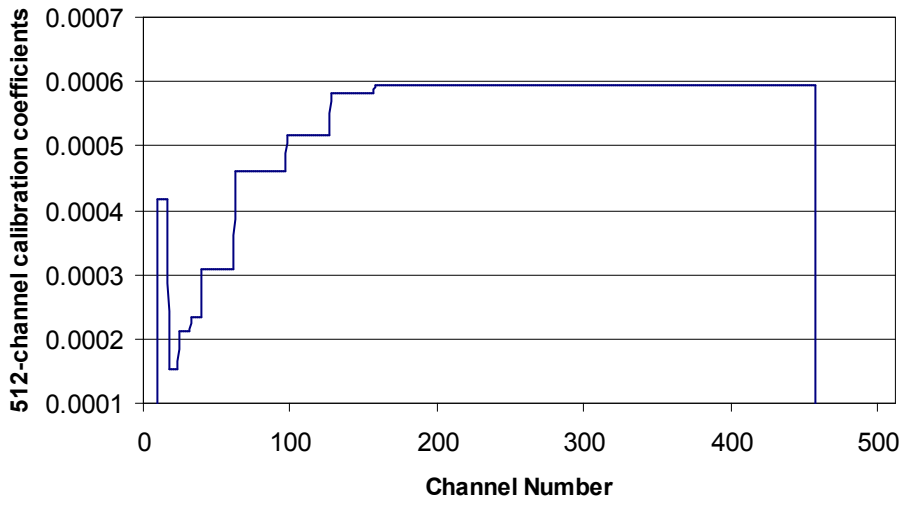


Figure 3. The 512-channel vector for converting the energy deposited in each channel to air kerma.

MEASUREMENT OF AIR KERMA RATE

In using the GR320 to measure air kerma rate, the spectrometer must be set-up the same way it was for the calibration. With spectrometer in the 256-channel mode and the ^{137}Cs peak at 662 keV in channel 55 would normally result in the 2615 keV peak from ^{208}Tl being in channel 207 or 208. It is also important that the stabilization source of ^{137}Cs should be removed from the detector, otherwise this source will contribute significantly to the calculated air kerma rate. If the system is left to run automatically, then the thorium peak at 2615 keV should be used for gain stabilization.

The GR320 spectrometer is calibrated for a semi-infinite source of gamma radiation with the front face of the detector facing the source of the radiation. In measuring the air kerma rate due to ground sources of radiation, the front face of the detector must be mounted with the front face of the detector facing the ground. This means that the photomultiplier end will be pointing upwards.

The sodium iodide detector responds differently to high-energy cosmic radiation compared to natural gamma radiation. Consequently, in using the derived calibration coefficients for measuring simultaneously gamma and cosmic radiation, the calculated total air kerma rate will be incorrect. Measurements made on a large body of water have shown that the cosmic ray background as calculated from the coefficients in Table 2 is 2.25 nGy h^{-1}. This is not the correct cosmic ray background of approximately 30 nGy h^{-1}. Because the cosmic background is calculated incorrectly, the GR320 software automatically subtracts an overwater background of 2.25 nGy h^{-1} from any measurement. Since the calculated total air kerma rate does not include the cosmic ray background, it will therefore be significantly lower than measurements made with an ionization chamber.