Gamma Spectacular manual

GS-USB-PRO

Gamma Spectrometer

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BEE RESEARCH PTY LTD

CE

EU DECLARATION OF CONFORMITY (NO# 00002)

MODELS # **GS-USB-PRO** (Serial numbers 1000 to 2000)

Description: **USB Audio adapter for photomultiplier tubes**

Manufacturer: **Bee Research Pty Ltd**
Address: **Suite 315 (level 3)**
247 Coward St.
Mascot NSW 2020

This declaration of conformity is issued under the sole responsibility of Bee Research Pty Ltd.

The objective of this declaration is to claim conformity with the following directives of the European Parliament.

2012/19/EU - **Waste and electrionic Equipment**
The described product may be returned to original manufacturer for recycling at end of life.

2011/65/EU - **Hazardous substances in electronic equipment**
The described product does not contain lead or any other restricted substance in excess od the described directive.

2014/30/EU - **Electromagnetic compatibility**
Providing it is used as described, the product is compliant with the general requirements 1(a) and 1(b) in Annex 1 of the directive.

Sydney 15/07/2017
Signed for and on on behalf of:
Bee Research Pty Ltd

Steven Sesselmann
Director

SAFETY INSTRUCTIONS

WARNING HIGH VOLTAGE

Always disconnect power before opening

The GS circuit operates at potentials up to 2000 volts
and may severely shock a person
(painful usually not deadly)

Care should be taken when connecting or disconnecting
Live SHV cables to avoid shock.

Keep away from water.

RADIOACTIVE MATERIALS HANDLING

Follow the appropriate safety procedures when
working with radioactive materials,
avoid unnecessary exposure,
Use personal protection to avoid skin exposure .
Avoid any food or drink in areas where
Radioactive materials are used.

Google:

[Safety when handling radioactive materials]

for more information.

INTRODUCTION

Congratulations, you have just purchased a third generation Gammaspectacular. The GS-USB-PRO connects to any PC or Mac via a standard USB 2.0 port and should work without any special driver installation. It is used with free PC software such as PRA, Theremino, or Becqmoni, and turns your computer into a professional gamma spectrometer.

The GS-USB-PRO works with most common radiation detectors, such as Geiger Mueller tubes and Scintillation detectors with photomultiplier tubes PMT's.

SPECIFICATIONS

Input Power	:	USB (+5V)
Maximum current	:	200 mA
Output Bias Voltage	:	0 - 2000 Volts (Variable)
HV Connector	:	SHV
Signal Input Connector	:	BNC
Analogue output option 1.	:	3.5 mm Mono Jack (TS)
Analogue output option 2.	:	3.5 mm Headset Jack (TRRS)
Analogue input right ch.	:	3.5 mm Stereo(TRS)Crossover
Default Audio Channel	:	Left
Optional input	:	Right
Sample rate	:	48 kHz
Bit rate	:	16 bit
Signal to Noise Ratio	:	73.9 dB
Preamp. volume (adj)	:	0 - 3.3V
Pulse length (adjustable)	:	5 - 100µs
Dimensions	:	165 x 115 x 35 mm
Weight	:	approx. 450 grams

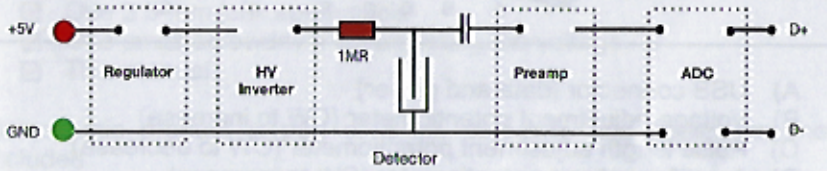
STANDARD INCLUSIONS

1 x GS-USB-PRO Spectrometer
1 x 2.5 mm Screwdriver
1 x USB type A to Type B Cable
1 x 3.5 mm Mono Audio Cable

OPERATING PRINCIPLE

The GS-USB-PRO is powered via USB and provides a stable high voltage positive bias adjustable from zero to 2000 volts, suitable for most common radiation detectors.

The pulse from a single wire detector is decoupled in the GS-USB-PRO and, amplified through an impedance matching preamp. The pulse is digitised by an inbuilt audio codec and sent to the computer via USB. The data stream is then analysed by multi channel analysis software on a PC.



The GS-USB-PRO model also features a BNC signal input port for two wire detectors with integral coupling. A dip switch under the unit bypasses the internal coupling when used in two wire mode.

High resolution pulse height analysis is achieved through smart software algorithms, which calculate the pulse height in real time. Up to 60 sample points per pulse are used to achieve high resolution spectra.

The maximum count rate is determined by the sample rate and number of samples selected in settings (up to 2500 cps. with good results).

The typical spectral resolution acieved is typically within 0.3% of the theoretical limits of the detector when properly adjusted.

To get the most from your GS follow the quick setup instructions in this manual and refer to the specific software manuals for more detail.

Happy experimenting!

External Controls and Connectors

A) USB connector (data and power)
B) Voltage adjustment potentiometer (CW to increase)
C) Pulse length adjustment potentiometer (CW to decrease)
D) Amplifier volume potentiometer (CW to increase)
E) Combination Jack Plug TS - TRS - TRRS
F) BNC detector signal Input
G) SHV high voltage detector bias

There are two dip switch settings under the GS-USB-PRO, one selects between single and two wire detectors and the other changes the function of the jack plug from Tip, Ring, Sleeve (TRS) Jack to Tip, Ring, Ring, Sleeve (TRRS) jack.

STEP BY STEP SETUP INSTRUCTIONS (with PRA Version 24.0.0)

The following instructions are intended as a quick set up guide only, and are not comprehensive. It is strongly recommended that the user read the latest software manual that comes with your version of PRA software.

1. Check if you have received all components
Your GS-USB-PRO should come with the following:

- ☑ One USB cable
- ☑ One 3.5 mm jack audio cable
- ☑ One small screwdriver for adjusting the voltage
- ☑ This manual.

Unless this product is part of a kit, detectors and cables are not included.

2. **Connect** the GS-USB-PRO to a suitable PC
Immediately on connecting the GS to a live USB port, the voltage display should light up.
note: The GS-USB-PRO does not have an on/off switch

3. Check PC connection
Open the PC control panel > Sound > Recording and confirm that the computer has recognised the device as "USB AUDIO CODEC" optionally check the box "Listen to this device" if you want to hear the sound from your detector. No driver installation should be required.
note: If step 3 fails try disconnecting and re-connecting the USB.

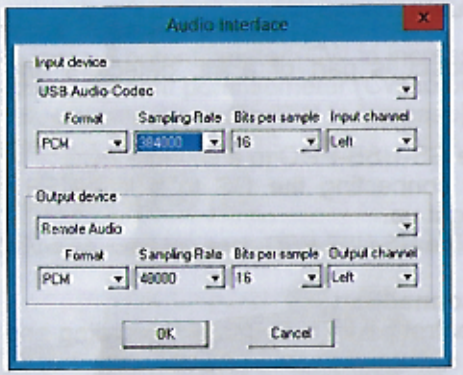
4. Adjust the bias voltage
Use the 2.5 mm screwdriver provided and set the voltage by trimming the potentiometer (B) until the voltmeter displays the recommended voltage for the intended detector.
The voltmeter measures voltage above the 1 Mohm coupling, for detectors with very low impedance dividers the voltage display may read low.

5. **Download PRA** and install the latest software version
Download link at:
https://www.gammaspectacular.com/software-downloads

5. **Run** Pulse Recorder and Analyser (PRA)

6. **Go to Settings >> Audio interface,** and select input device "USB Audio Codec" , Left channel and Sample rate 384 kHz.

note: Right channel is only used for coincidence counting.
note: Even though the ADC input samples at 48 kHz, selecting a higher sample rate improves results. The sample window is the product of time between samples and number of sample points used. Choose a sample rate and number of samples to create a reasonable size sample window to capture a 100 µs pulse. Set the sample rate to 384 kHz if using all 60 sample points this will give you a 2.6 µs x 60 samples = 156 µs window.



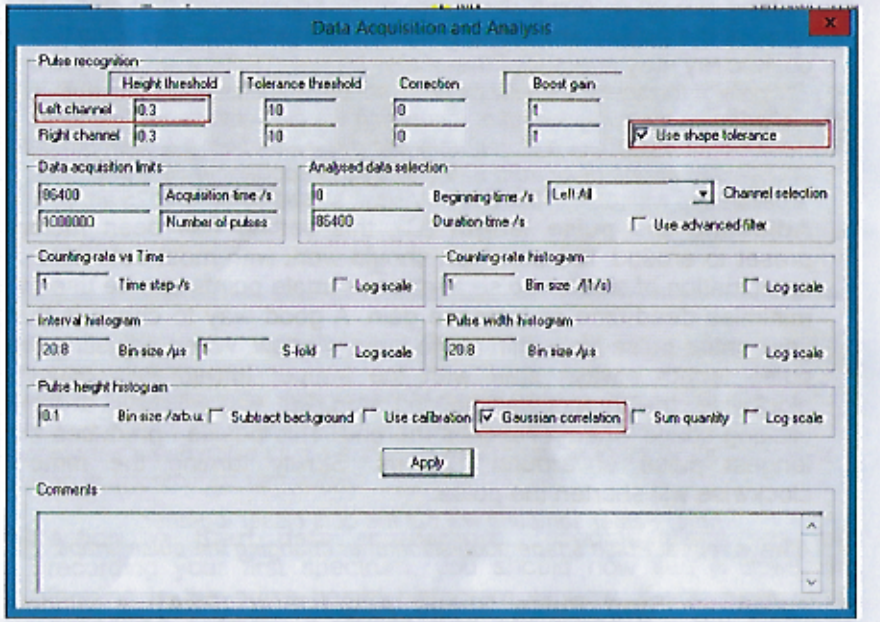
7. **Connect a detector** to the GS-USB-PRO using a proper high voltage coaxial cable with suitable SHV connector, optionally connect a signal cable to the BNC port if your detector has internal coupling. Check that the voltage is in the correct range for your detector.

note: Most detectors will have an acceptable plateau of a few hundred volts.
note: single wire detectors connect the SHV port, if your detector has a BNC connector you will need an adaptor cable.
Do not use cheap coaxial cables with foam core!!

6. **Open these windows** in PRA
    1. Settings >> Data acquisition and analysis (DAA)
    2. View >> Counting rate vs time
    3. View >> Pulse height Histogram
    4. View >> Audio input

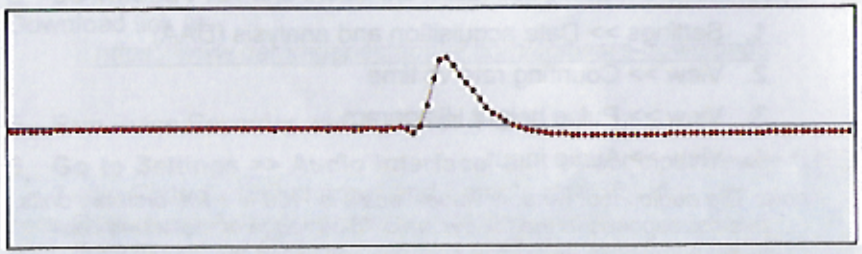
note: The audio input window vertical scale is -100 to +100 arbitrary units, this corresponds to the full dynamic 16 bit range of the sound card

5. In the DAA window **start with the default settings** below.



6. Go to Action >> **Start pulse shape acquisition**, the left channel pulse trace should now be visible in the Audio Input window.

observe: Are pulses positive or negative ?
If negative, go back to step 5 and change the Pulse height threshold to a negative number



7. **Adjust the volume**, observe the pulse height and adjust the volume (D) up or down using the small screwdriver provided, until most of the pulses are within range of your window. (the occasional cosmic ray may overshoot the scale)

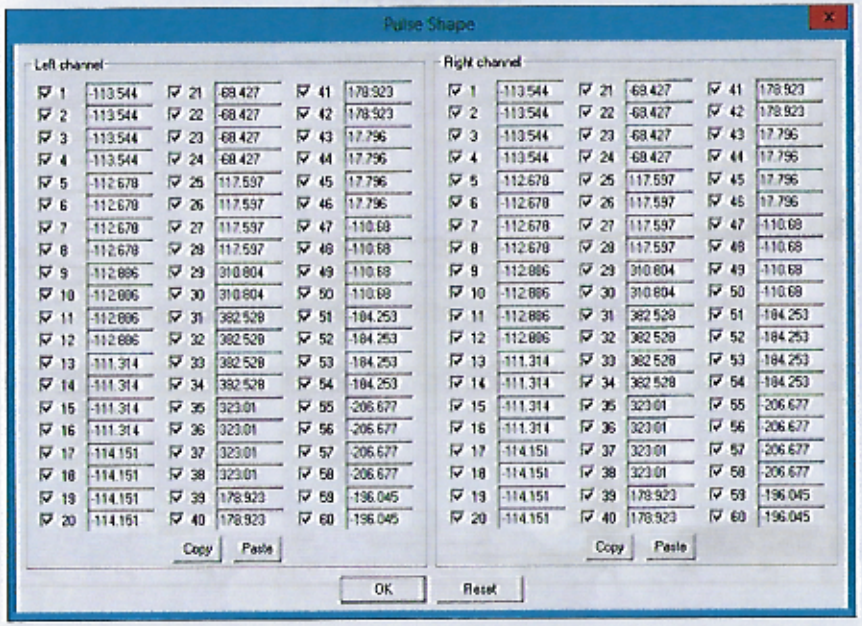
note: if the sound card range does not allow sufficient adjustment, shortening the pulse length or increasing the bias voltage will increase pulse height. For spectra of naturally occurring isotopes, the optimum gain is when the peak from K40 (1460 keV) appears at 50 arb.u.
If calibrating with Cs137 the 662 keV peak should be around 25 arb.u.

8. **Adjusting the pulse length** (C), this setting has been factory preset to around 100 µs which should work with most detectors. A combination of shorter pulse and less sample points can be used to minimise dead-time or increase gain. A good way to check is that your entire pulse fits within audio input window. When adjusting the pulse length always start with the trimpot turned fully counter clockwise, the trimpot has no end stop, but you will hear a slight clicking sound when it reaches the end. This position produces the longest pulse of around 125 µs. Slowly turning the trimpot clockwise will shorten the pulse.

note: Faster sampling will put the dots closer together.
Always repeat Pulse shape acquisition after changing the pulse shape.

9. Action >> **Stop Pulse Shape Acquisition (PSA)**, a window showing the mean sample points will pop up and ask you to confirm by clicking OK.

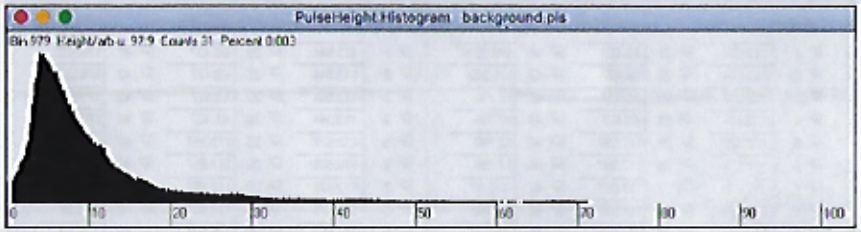
note: The pulse peak is always around sample 30, so deselecting equal number of samples at the beginning and the end will create a narrower window.
note: If you make adjustments to any of the hardware parameters you will need to repeat the Pulse shape acquisition again..



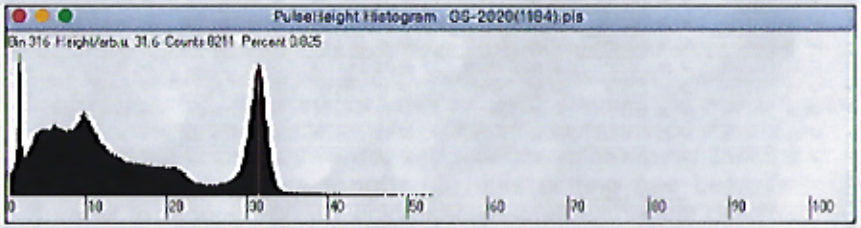
Why are we doing this?
Random pulses from the detector occasionally overlap, this results in pulse pile up (PPU), these malformed pulses need to be filtered out. The PSA action records the mean pulse shape and uses this shape factored by the tolerance setting to discriminate bad pulses.

10. Action >> **Start data acquisition** , congratulations you are recording your first spectrum, you should now see a spectrum forming in the pulse height histogram window. If you have done everything correctly it should look something like the following sample spectra.

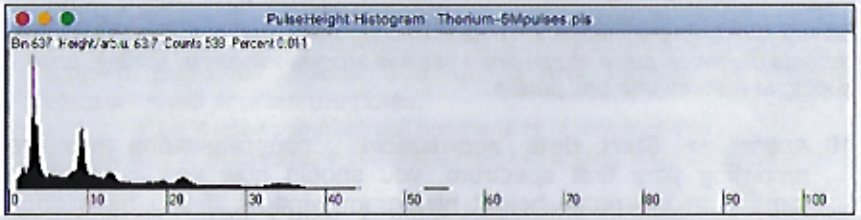
Samle Spectra



Sample of background spectrum taken with a 2" detector

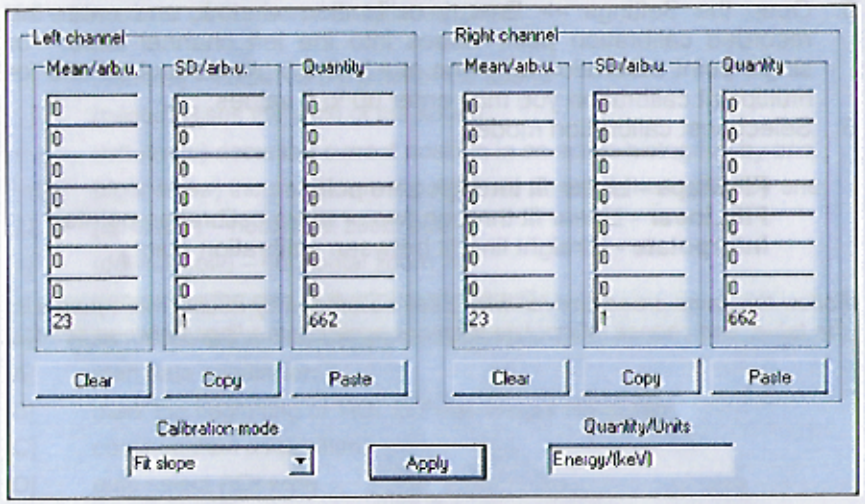


Spectrum of Cs137 with 2" detector



Spectrum of Thorium taken with 2" detector

Energy Calibration



The horizontal axis of the pulse height histogram by default displays 100 arbitrary units (arb.u.), this represents the full energy range of the analogue to digital converter (ADC). It is therefore important that the chosen voltage/volume combination has been carefully chosen to make full use of the range. A good rule of thumb is to set the volume so K40 (1460 keV) appears at 50 arb.u. K40 is present everywhere and will show up in your spectrum after a few minutes recording, so no special calibration source is required for this.

Steps for Calibration Using One Peak

1. Record a good spectrum with one well defined known peak.
   spectrometry is a visual art recognising peaks takes some practice
2. Tick the box called Gaussian in the DAA this will make it easier to identify peaks in your spectrum
3. Select the region of interest (ROI) by clicking on a bin to the left of the peak and pressing "b" for beginning, then clicking a bin immediately to the right of the peak and pressing "e" for end, the ROI should now be highlighted in yellow.

note: The ROI should include the entire area of the peak

4. Select any bin inside the region of interest and note the mean arb.u as well as the standard deviation (SD).
5. Open the Settings >> Energy calibration window, and enter the recorded calibration point values into the left channel table. For single point calibration only one row in the table is required and for multipoint calibration you may enter up to 8 values.
6. Select best calibration mode;

Fit Slope - Linear fit through zero point
Fit Linear - Linear fit through two or more calibration points
Interpolate - Straight line fit between calibration points

Follow the same procedure for multi peak calibration by adding more points in the table, and choose interpolate for more accurate readings between points.

PRA SHORTCUTS

It is a good idea to memorise some of the keyboard shortcuts in PRA, Here are some of the commonly used ones:

[,]	(comma) – Reduces the pitch of the sound.
[.]	(period) Rises the pitch of the sound.
[←]	(left arrow) decrease current position in an active histogram by one.
[→]	(right arrow) increase current position in an active histogram by one.
[↑]	(up arrow) – horizontal zoom out.
[↓]	(down arrow) – horizontal zoom in.
[<]	decreases the rate of the "played pulses".
[>]	increases the rate of the "played pulses".
[A]	start data acquisition.
[B]	mark the beginning of 'ROI' in Pulse Height Histogram.
[C]	continue data acquisition.
[D]	auto select ROI wide
[E]	mark the end of 'Region Of Interest'.
[F]	auto select ROI normal
[F1]	activates all "Save" menu items during data acquisition
[G]	auto select ROI narrow
[H]	auto select ROI very narrow
[K]	mark all ROIs in the right channel identical to the left channel ROIs.
[L]	toggles automatic selection of the last entry in Counting Rate vs Time
[Q]	opens Information dialogue box which can be read by "JAWS"
[S]	stop data acquisition.
[T]	audio input trigger mode
[Delete]	clears selected ROI in pulse height histogram.
[Delete + Shift]	clears all ROI's in pulse height histogram.
[Space Bar]	Start or stop 'playing' pulse sound.
[Page Up]	vertical zoom (also Mouse Wheel)
[Page Down]	vertical zoom out (also Mouse Wheel)