Users Manual for the

Model W202

Gamma-ray Spectrometer

Overview

The SEE Co. Model W202 Gamma-ray Spectrometer is a compact, highly integrated system providing both Pulse-Height Analysis (PHA) and dual Single-Channel Analysis (SCA). The user interface is provided via a USB link to a Windows PC. The SCA TTL pulse output may be routed to the input of a separate Multi Channel Scalar (MCS). The discussion below assumes that the W202 is to be used as a part of a Mössbauer Spectrometer with a Kr gas proportional counter. Many other applications of the W202 are possible.

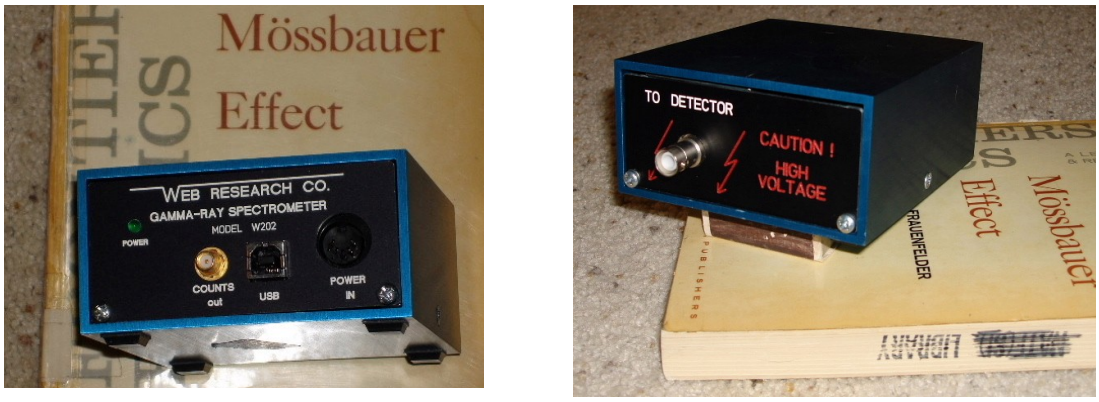

Fig 1. Front and Rear views of the W202 Gamma-ray Spectrometer.
Case dimensions are 5 cm x 10 cm x 12 cm.

Block Diagram and External Connections

See Fig. 2 on page 2.

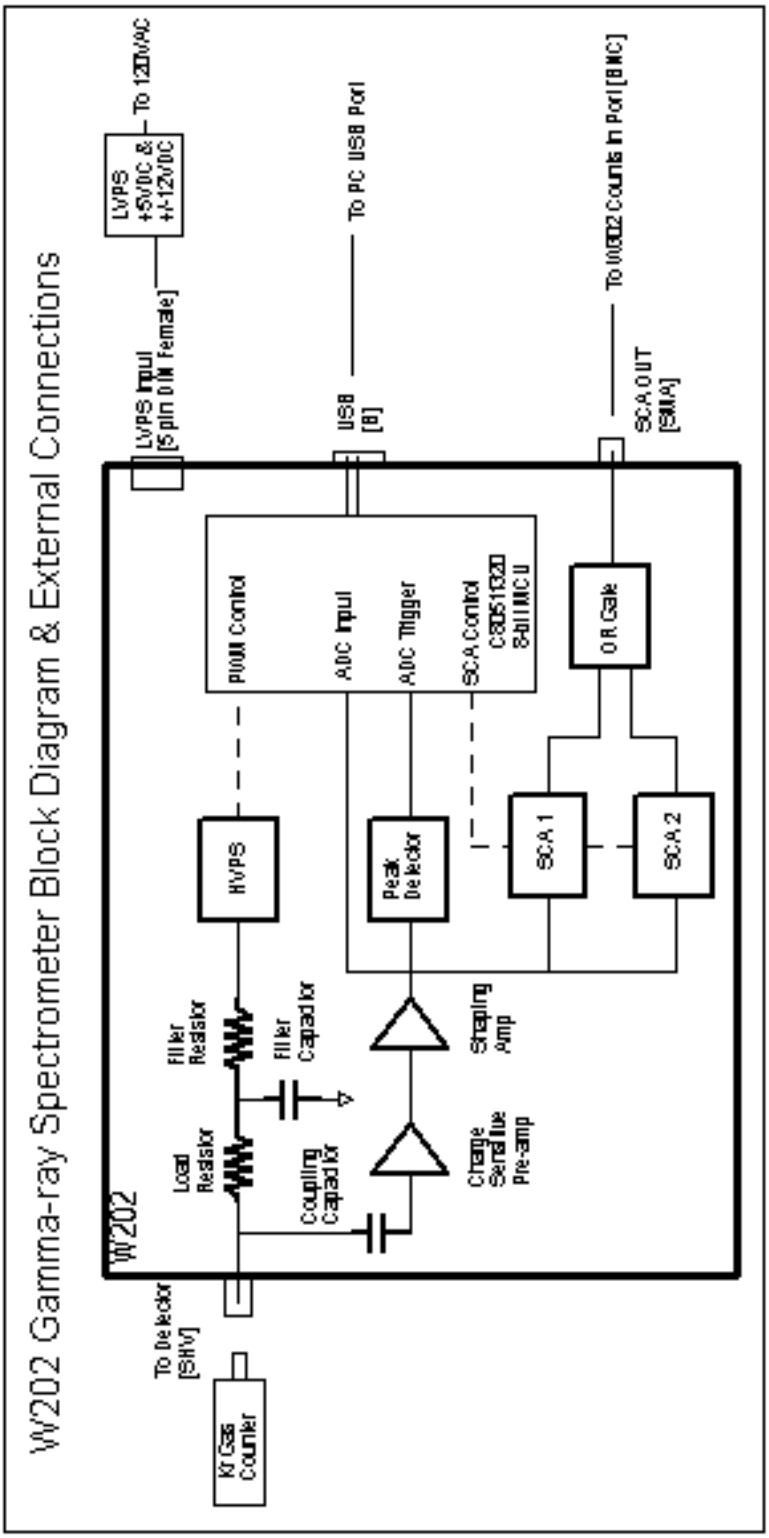
W202 Gamma-ray Spectrometer Block Diagram & External Connections
LVPS +5VDC & +/-12VDC
To 120VAC
LVPS Input [5 pin DIN Female]
To PC USB Port
USB [B]
To W202 Counts In Port [BNC]
SCA OUT [SMA]
PWM Control
ADC Input
ADC Trigger
SCA Control
C8051F320 8-bit MCU
OR Gate
HVPS
Peak Detector
SCA 1
SCA 2
Filter Resistor
Filter Capacitor
Shaping Amp
Load Resistor
Coupling Capacitor
Charge Sensitive Pre-amp
W202
To Detector [SHV]
Kr Gas Counter

Figure 2.

Setup & Operation

Before plugging power supply into 120 VAC, connect all cables as illustrated in Fig. 2. Power should be disconnected anytime a cable is inserted or removed from the W202 unit.

With all cables connected, plug power supply into 120VAC source. Often this would be a battery backed up UPS. The W202 has no on/off switch.

If a computer was purchase with the W202, the W202 user interface software will be already installed on that MS Windoes PC. If not, see the W202 PC software documentation for installation instructions. After the PC software is properly installed, execute the program W202.exe by double clicking on the W202 icon on the PC desktop. If all cable connections are correct, you will see the dialog box shown in Fig. 3. The drop down list will show all W202 units that are connected to the PC. Select the unit you require and then click OK. Clicking Cancel will terminate the W202 program.

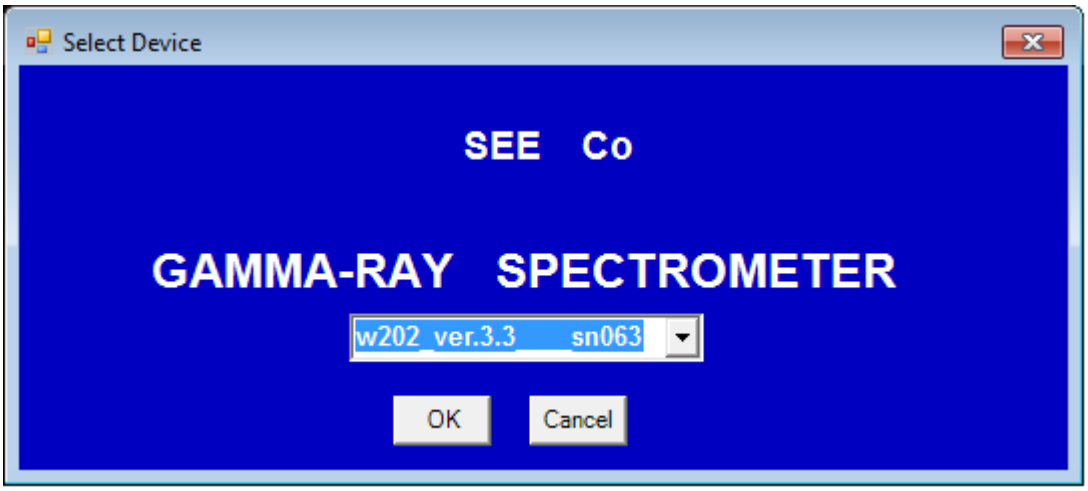

Fig. 3. Initial "Select Device" dialog box . Clicking the down arrow will display a list of all W202 units connected to the PC.

After the Select Device form closes, the Main Form of the W202 PC software will appear as shown in Fig. 4. The central area is used for the plot of the pulse height spectrum. The horizontal axis units of the PHA plot has units of Channels. The range of 256 channels corresponds to the 8-bit ADC used to convert the peak voltage value. Channel 256 corresponds to the 12 V reference voltage.

On the lower left is a display/edit box for the DC voltage applied to the detector. Units are Volts. The voltage is controlled by clicking on the arrows or entering a number via the keyboard. **After the user has changed the voltage value, several minutes are required for the voltage at the detector to stabilize. An accurate pulse height spectrum will not be generated until the voltage is stable.** Use the Clear button to remove any data collected during the time of unstable voltage.

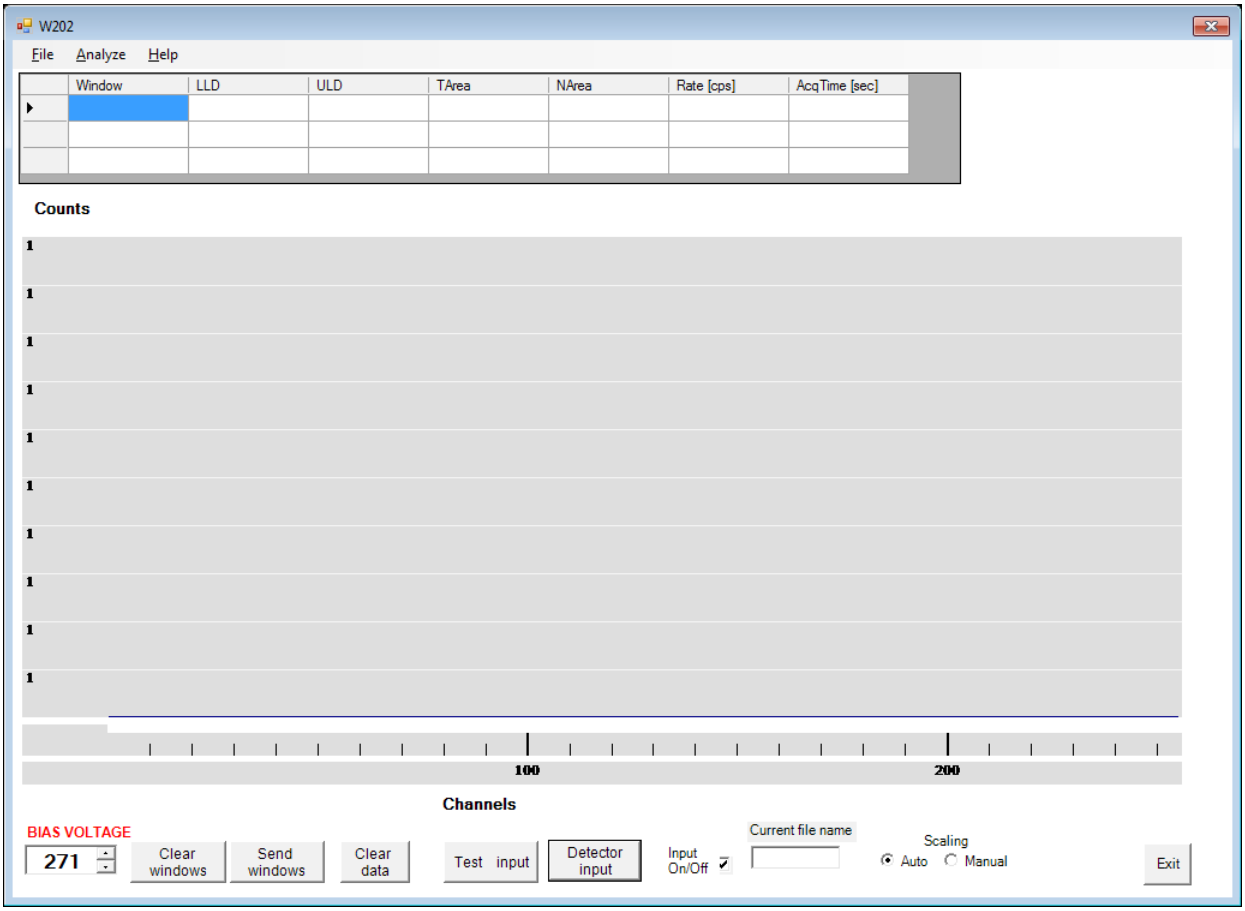

Fig. 4. W202 PC Software main form.

The input to the Peak detector is selected by the "Test Input" and "Detector Input" buttons. Clicking the Test Input button causes internally generated pulsed of two fixed heights to be

routed to the pre-amp input. See Figure 5. This function is used to verify the W202 is working properly independent of the detector. The positions of the test pulses on the PHA plot are independent of the High Voltage setting.

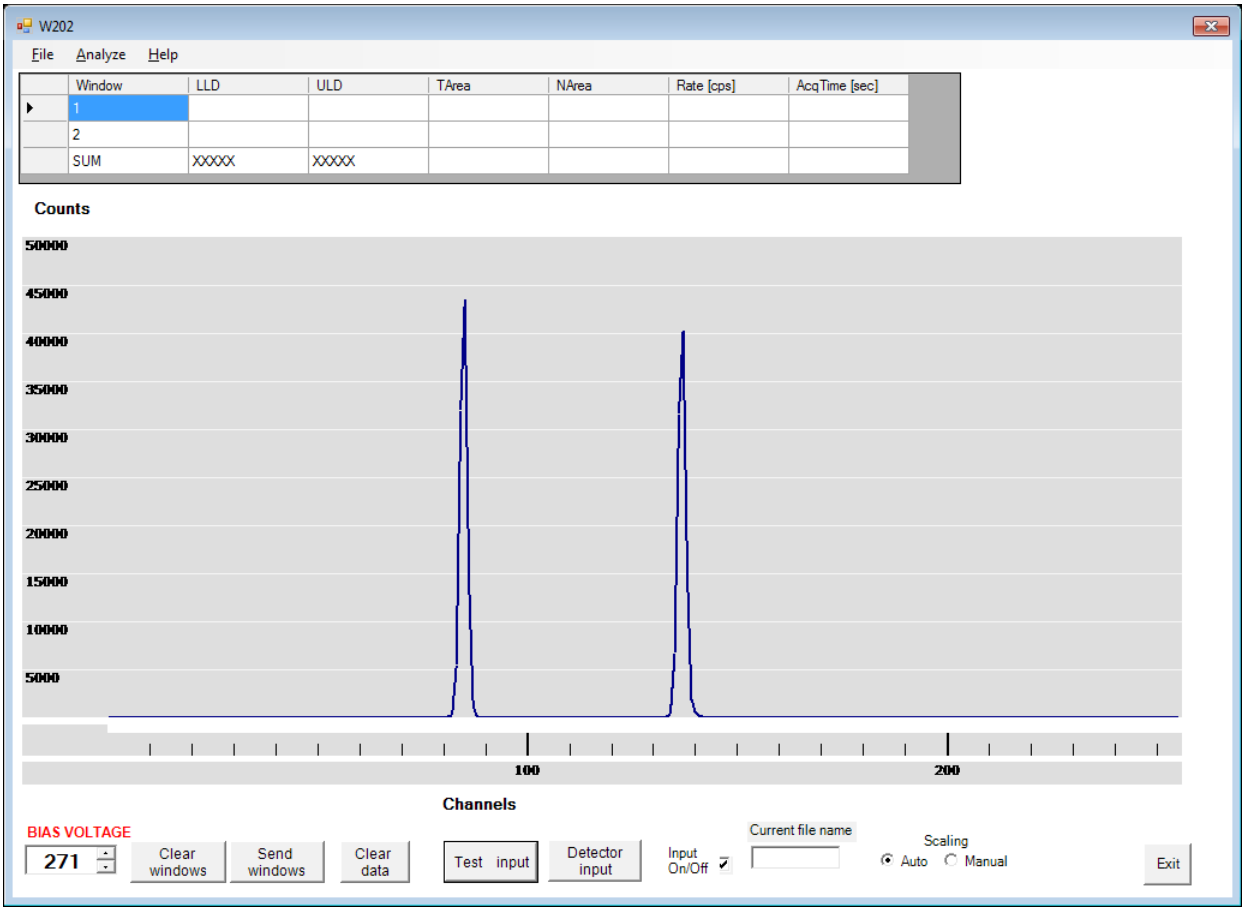

Fig. 5. Display of Pulse Height Spectrum of Test Input pulses.

To activate the input from the detector, click the "Detector Input" button. If the W202 is connected to a Kr gas counter (detector), use the arrow buttons in the lower right corner to increase the High Voltage to until the 14 keV gamma peak is at approximately channel 100. Again, after the HV has been changed, it can take as long as 20 s for the voltage at the detector to stabilized. Once the HV is stable and if you have a Co-57 gamma-source shining on the detector window, you will see the pulse height spectrum growing in amplitude as shown in Fig. 6. The actual HV required depends of the particular detector and the gain and filter settings in the W202. Normally, for a Kr gas counter with 1 atmosphere Kr/CO2 gas pressure and a 0.002 inch diameter center wire, the HV will be in the range of 1,500 V to 2,000 V.

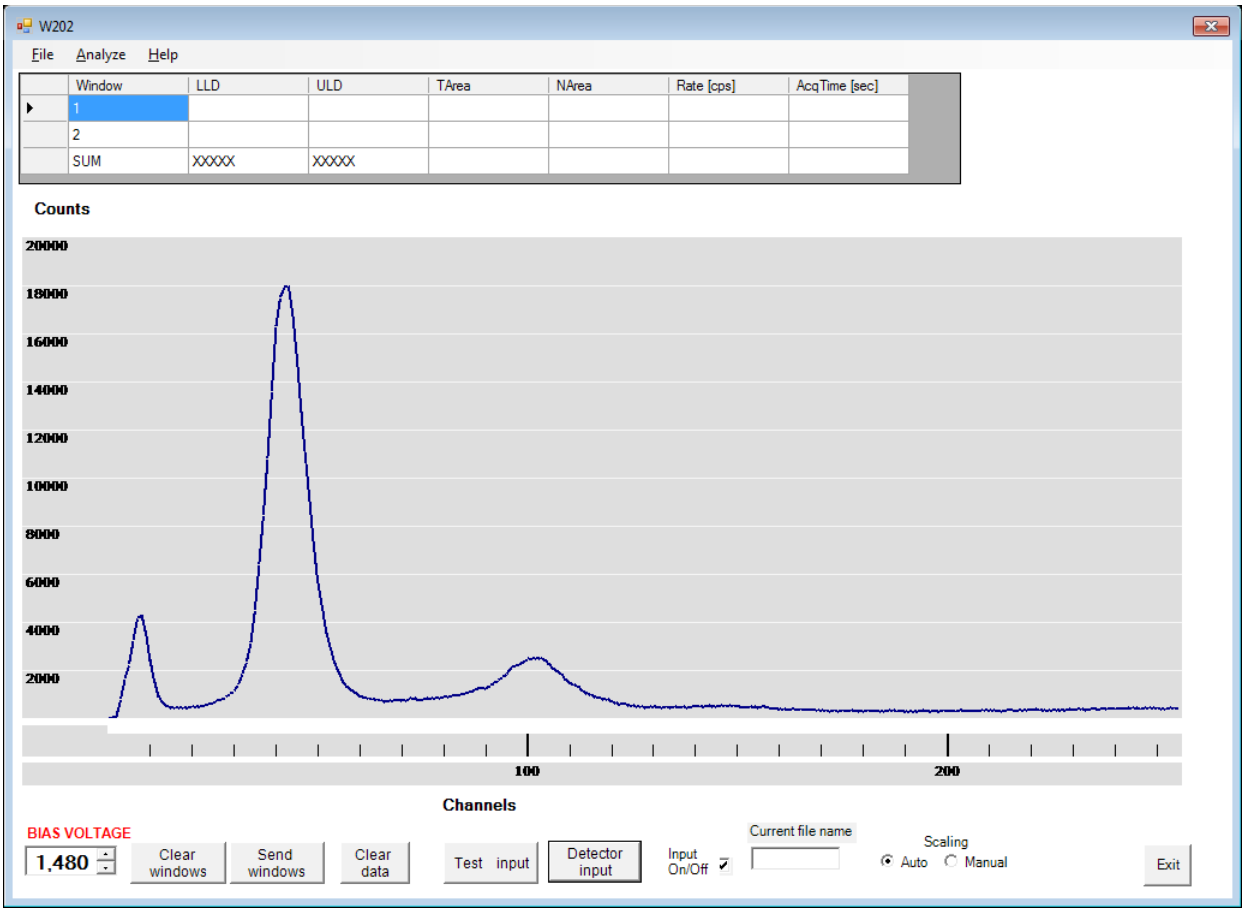

Fig. 6. The pulse height spectrum of a 5 mCi Co-57 Mossbauer source with a Rh matrix. The source to detector distance was 65 mm. A Pb shield with a 17 mm diameter aperture was in front of the Kr gas counter.

From left to right, the peaks are: the 2 keV Escape peak due to the 14.4 keV gammas, the 6 to 7 keV Iron X-rays, the 14.4 keV gamma and the 22 top 24 keV Rhodium X-rays. For Fe-57 Mossbauer spectroscopy the 14 keV Gamma peak and the 2 keV Escape peak need to be counted. The 6 keV X-rays are unwanted. At higher count rates the 6 keV absorption events can generate pulses in the detector that overlap in time with the pulses due to the gamma and reduces the gamma counting efficiency. Often non-resonant absorption by the sample in a transmission mode experiment will reduce the 6 keV rate so that the X-rays are not a problem. If not, then a high pass filter can be placed in the beam to absorb the 6 keV X-rays before they enter the detector. Fig. 7 shows the effect as placing a 3 mm thick plastic ("Lucite") filter in front of the detector window.

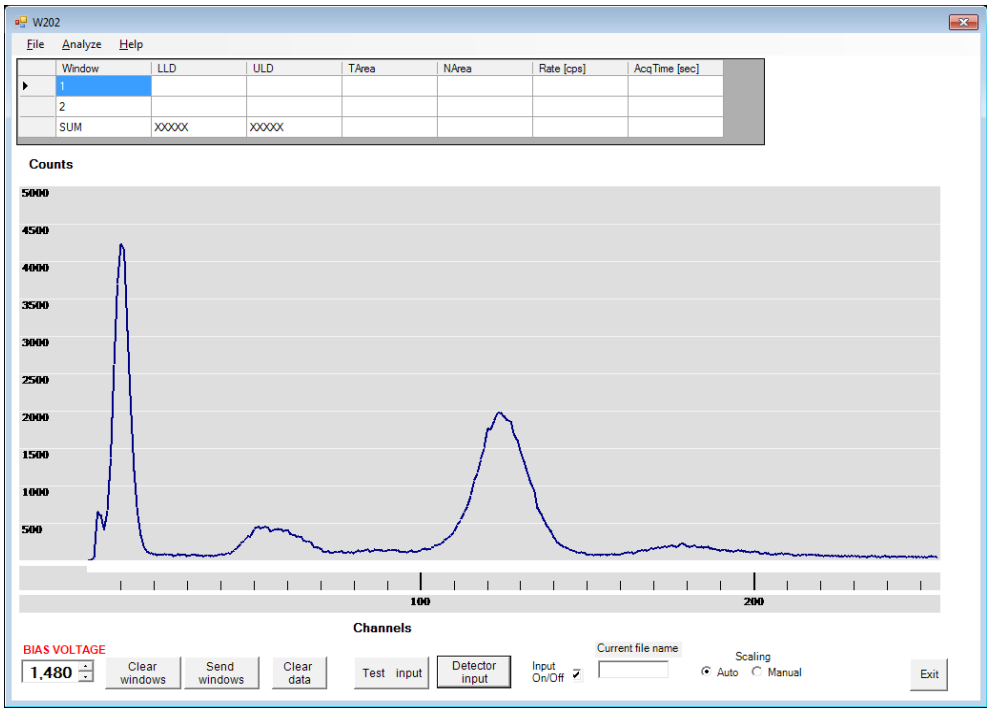

Fig. 7. Same experiment as Fig. 6 but with 3 mm plastic filter in beam. The 6 keV Fe X-ray peak is suppressed relative to the 14 keV Gamma peak and the 2 keV Escape peak. Also, the Escape peak at 10 keV due to the 22 keV Rh X-rays in now partially resolved.

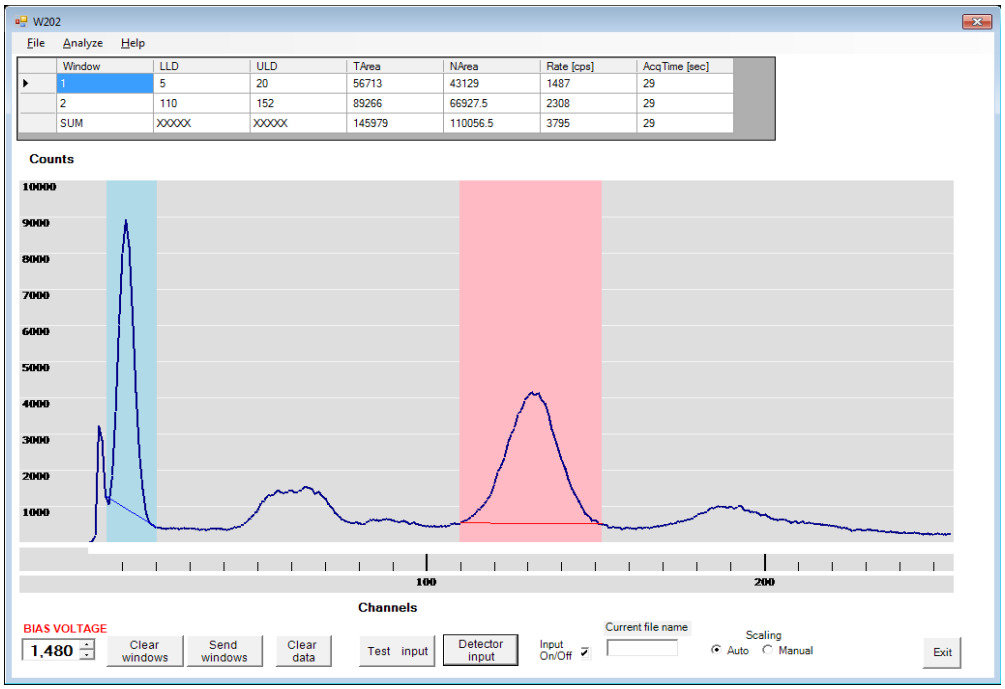

Fig. 8. Same as Figure 7 except a 27 um thick natural Iron foil was added in beam. The small peak at the extreme left is due to electronic noise. The SCA windows are indicated by the blue and pink background colors. See text.

Placing a sample in the beam will reduce the 14 keV peak height relative to the background generated by the 122 keV gammas Compton scattering off electrons in the Kr gas. Figure 8 shows the pulse height spectrum of the Co-57 source after a 27um thick natural Iron foil is placed in the beam in addition to the 3 mm plastic filter .

Once the beam geometry is defined in terms of solid angle and absorbers in the beam, it is time to set the Single Channel Analyzers (SCA) windows. There are two independent SCA's in the W202 hardware. Two SCA's are provided to optimize the system for counting the 14 keV Gammas detected by a Kr gas counter. Approximately one third to one half of the 14 keV gammas absorbed in a Kr gas counter generate a 12 keV Kr X-ray that leaves ("escapes") the counter without interacting with the gas. For those escape events only a net energy of 2 keV is deposited in the detector by the 14 keV Gamma. Thus the peak at 2 keV in the PHA spectrum.

Set the window of SCA #1 by slowly dragging the mouse cursor over the the region of interest. This is done be holding down the left mouse button while moving the mouse. A blue background will appear on the PHA plot indicating the range of SCA #1's window. The range of the window is defined by the horizontal position of the mouse cursor. The left edge of the window defines the voltage level for the Low Level Detector for SCA #1. The right edge defines the voltage level for the High Level Detector for SCA #1. Once SCA #1's window is defined, clicking and dragging the mouse again will define SCA #2's window, denoted by the pink background color. See Figure 8.

After both windows have been set, click on Send Windows to transfer the window settings from the PC to the dual SCA's in the W202 hardware. This action will also clear the windows from the screen plot. See Figure 9. The windows settings are stored in the memory of four digital potentiometers in the W202.

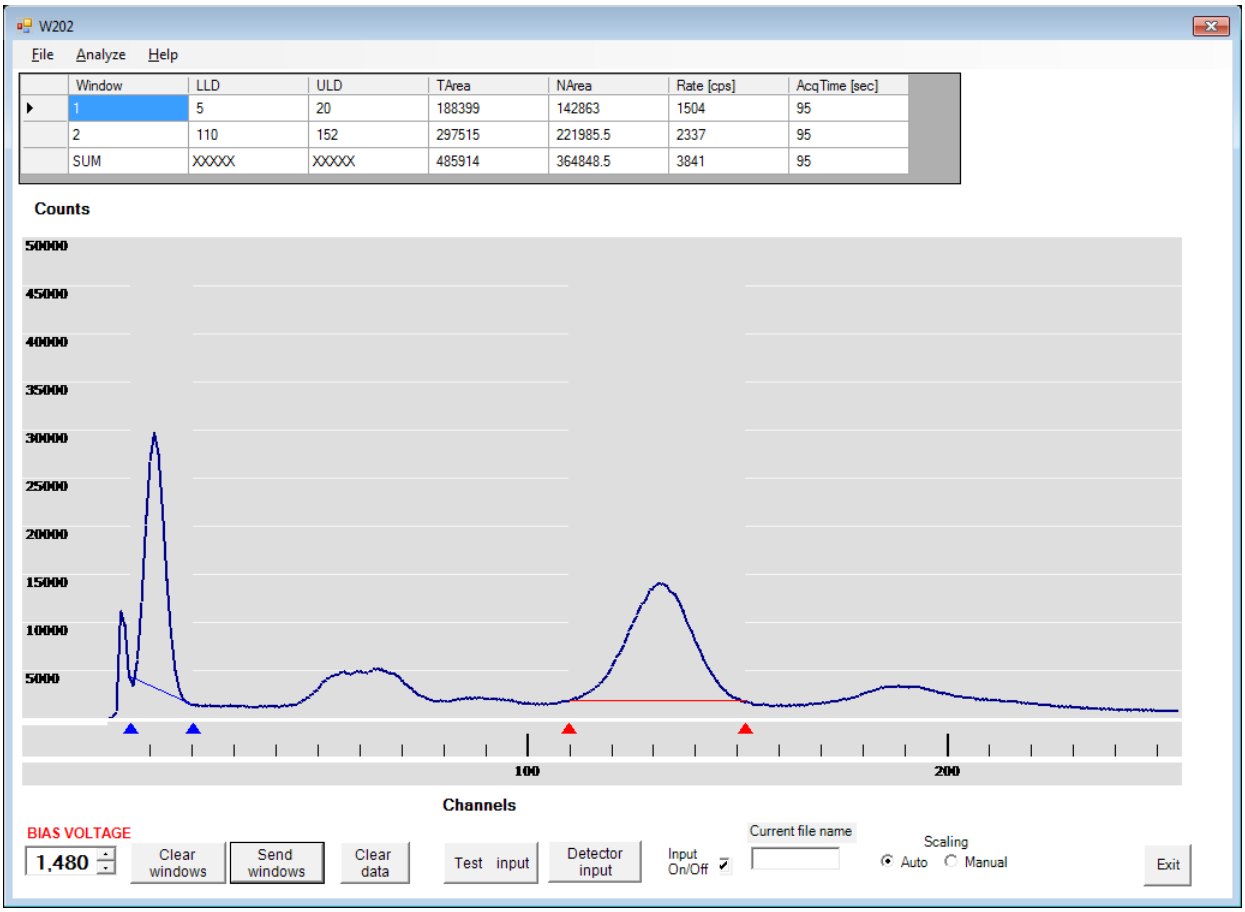

Fig. 9. W202 PHA display shown after Send Windows procedure has been executed. The blue and red markers denote the settings returned by the SCA#1 and SCA#2 hardware, respectively.

The "Counts Out" signal will now be a stream of TTL pulses generated by detector events that have a peak voltage height that falls within Window 1 or Window 2. These counts are routed to the SEE Co W302 Resonant Gamma-ray Spectrometer "Counts-1 In" or "Counts-2 In" when collecting a Mossbauer spectrum.

You can now terminate the W202 PC program by clicking on the Exit Command button at the upper left or on the "X" at the upper right. The W202 hardware will continue to generate the dual SCA output pulses until its power is removed or its settings are changed via the W202 PC program. **The W202 PC program does not need to be running to collect a Mossbauer spectrum. It is only used to set the dual SCA windows.**