Appendix XXIV: Quick Start – the NaI:Tl scintillator and the high purity Ge detector

Two different detectors will be used to measure the energy spectrum of gamma ray sources.

For each type of detector:

Set up electronics (refer to **Electronics setup and connections** sections)

With a sample such as ^{60}Co in front of the detector, adjust the FINE GAIN 2.5-12.5 dial on the panel of 575A AMPLIFIER to reach the peak amplitude (so that the energy range you are interested in is within channels 1-4000). Use the MAESTRO program of the multichannel analyzer (MCA) plug-in card in the computer to monitor the gain. Note that the ADC of the MCA has a nominal conversion gain of +10V to channel 4000.

Remove the sample and collect data for background radiation (refer to **Data collection**.). Collect background radiation data for approximately the same time duration as you expect to use for the samples. Save the data for background (see **To save data**).

Collect and Save Data for each sample (refer to **Data collection** and see **To save data**). Strip the background data from the sample data, for each sample (see **To load data to BUFFER** and **To strip background from buffer**). Save again using different filenames (see **To save data**).

Electronics setup and connections

A. The HPGe (High Purity Germanium (Ortec GEM10 P4-70) detector together with its preamplifier is enclosed in a metal cylinder and has to be cooled down with liquid nitrogen (LN_2) for several hours before use. (At room temperature, the application of the +2.5kV bias will cause drift of the Li dopants at room temperature, eventually destroying the detector.)

1. Connect OUTPUT1 of the HPGe detector to the INPUT on the back panel of 575A amplifier.
2. Connect the BIAS SHUTDOWN from the HPGe detector to the BIAS SHUTDOWN on the back of 659 0-to-5 KV bias supply.
3. Connect the BIAS SUPPLY input (thicker white coaxial cable) of the HPGe detector to 0-5 kV OUTPUT on the back of 659 0-to-5 kV bias supply.
4. Connect the PREAMPLIFIER POWER input (gray cable) of the HPGe detector to the 9-pin POWER PREAMP connector on the back of 575A amplifier.
5. Connect BI OUT (bipolar output) on the panel of 575A amplifier to INPUT 1 or 2 of the oscilloscope. Set the scope for internal trigger on the appropriate signal.
6. Connect UNI OUT (unipolar output) on the panel of 575A amplifier to ADC input of the ADC card on the back of the computer.
7. Turn the power on by setting the switch on the panel of Ortec 401A power supply to ON.
8. POS and SHUTDOWN indicators on the panel of 659 0-to-5 kV bias supply should be on. Push the RESET button on the panel of 659 0-to-5 kV bias supply once. The SHUTDOWN indicator should go off indicating that the detector temperature is cool enough. **If at this step the SHUTDOWN indicator is still on, STOP and ask for instructor's help immediately.**

(Note: the 9-pin preamp power cable must be plugged in for the SHUTDOWN interlock to be satisfied.) Turn on the HV switch and push RESET button on the panel of 659 0-to-5 kV bias supply again. Both the ON and POS indicator LEDs should now be on.

9. Apply approximately +2.0 kV of bias voltage to HPGe detector by rotating the 0-5 KV dial on the panel of the 659 0-to-5 kV bias supply (approximately 2.0 rotations of the dial, four LED bars in the indicator window will turn on).
10. On the panel of the 575A amplifier, set INPUT to POS and COARSE GAIN to 10. Using FINE GAIN dial, adjust the amplification so the majority of the output pulses have tops of their positive polarity peaks below +10 Volts. Use the oscilloscope to observe the amplitude and polarity of the output signal and use the MCA to check the ADC conversion gain.
11. **To turn off**, use the 0-5 kV dial on the panel of 659 HV supply to decrease the HV to zero. On the same unit turn off the high voltage by setting the HV switch to OFF. Turn OFF the NIMBIN Ortec 401A power supply.

B. Scintillator, photomultiplier detector, and 113 preamplifier in a separate unit.

1. Connect the OUTPUT of the photomultiplier through 1MΩ-1μF RC network to the INPUT on the panel of the 113 preamplifier.
2. Connect POWER (gray) cord from the back of 113 preamplifier to the 9-pin POWER PREAMP socket on the back of the 575A amplifier.
3. Connect OUTPUT on the back of 113 preamplifier to INPUT on the back of 575A amplifier.
4. Connect HIGH VOLTAGE input of the photomultiplier to HV OUT on the back of the Canberra 3002 HV SUPPLY.
5. Connect BI OUT (bipolar output) on the panel of 575A amplifier to INPUT 1 or 2 of the oscilloscope. Set the scope for internal trigger on the appropriate signal.
6. Connect UNI OUT (unipolar output) on the panel of 575A amplifier to ADC input of the ADC card on the back of the computer.
7. Turn on power to the Ortec 401A power supply by setting the ON/OFF switch to ON.
8. Apply +800 volts of high voltage to the photomultiplier by adjusting the **Canberra 3002** 0-to-3 kV HV supply. Note that the bias for the detector in use for Fall 2010 is positive. If the bias is set incorrectly (e.g., negative) on the Canberra 3002, turn off the 3002 and the Ortec 401A NIMBIN power supply, remove the 3002 from the NIM, and change the polarity to positive using a flathead screwdriver. After ensuring that the bias is set correctly and that the HV controls are set to zero, turn the power on to the Canberra 3002 HV supply. Next, turn the coarse control knob to 500 V, and adjust the dial to bring the total voltage to +800 V. Use the analog voltmeter on the panel of the same unit to observe the applied voltage.
9. On the panel of 575A amplifier, set INPUT to NEG and COARSE GAIN dial to 4 then using FINE GAIN dial, adjust the amplification so that the majority of the output pulses have tops of their positive polarity peaks below +10 Volts. If the pulse amplitude appears slightly too

low, you may gradually increase HV slightly the continuous dial knob to as high as approximately +850 V in order to attain peak heights as high as possible without more than ~1% or so exceeding the 12 V level and clipping as seen on the oscilloscope. If you find that a higher HV setting is required, consult with the lab instructor or TA. Use the oscilloscope to observe the amplitude and polarity of the output signal, and use the MCA to check the ADC conversion gain.

10. **To turn off HV** and power supply, turn down the HV dial setting on the Canberra 3002; then turn the coarse adjust knob from 500 to 0. Turn OFF the Ortec 401A NIMBIN power supply.

ADC card and MAESTRO program

The input to the ADC card should be positive pulses within the range of 0 to +10V. The card transforms the value of the positive maximum of each pulse into channel numbers in the range of 1-4096 (2^{12}). After sensing the positive slope of the start of the pulse, the card waits for it to reach its maximum value and then proceeds with digitizing. During this time the card cannot accept another pulse. The time during which ADC card is busy doing its job is called DEAD TIME.

To start the ADC card and MAESTRO program.

Turn the computer on. This version of MAESTRO runs under Windows XP. On the Windows desktop, run MAESTRO. When done, close the program, and shutdown Windows and the PC.

MAESTRO program

It plots a histogram of the number of pulses vs. amplitude accepting input from ADC card and puts them to MCB data storage. It also calculates LIVE time = REAL time - DEAD time; REAL time is the time elapsed from the beginning of data collection. It uses two data storage registers MCB and BUFFER. The screen display can be switched to display either MCB or BUFFER.

Data collection: For the time of data collection always use LIVE TIME. Clear the MCB if needed by choosing Acquire, Stop (if data acquisition is running), and Clear.

To start, switch display to MCB and the data range to full. Choose Acquire and Start. **To stop**, Choose Acquire and Stop. Data are now stored in the MCB.

To save data to the PC: Choose Acquire and Copy MCB→Buffer (data can only be saved from the Buffer). Choose File and Save as... Choose file type ASCII SPE, and use appropriate filename and extension corresponding to the ASCII SPE file type. Be sure you record the file name in your notebook.

To load previously acquired data to BUFFER: Go to File and Recall. You will be advised to save buffer, do it if you need as it will be lost after you load your file. Select the file….

To strip background from buffer: Go to Calculate … Strip. Select the background file (the file that you saved doing background measurements). Be sure that “Use Ratio of Live Times” is selected.