Measurement of Source Energy Spectra in MPPC 53

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Abstract

The results of measurement of ^{137}Cs and ^{22}Na source energy spectra using a Canberra Multichannel Analyzer are summarized. This is the first use of the ^{22}Na source with the Hamamatsu Multi-Pixel Photon Counters (MPPCs). A 1x1x10 mm^3 LYSO crystal butted onto the MPPC was used to absorb the γs from the sources. The mean peak in counts versus bias voltage is shown for ^{137}Cs measurements. The energy resolution is also calculated assuming an absolute zero scale for the Multichannel Analyzer.

Measurement Setup

The Multi-Pixel Photon Counter (MPPC) model S10362-11-050C Sample 53 was installed on our standard single channel board. The square cross section end of a 1x1x10 mm^3 LYSO crystal was butted against the MPPC and either a ^{137}Cs or ^{22}Na source was positioned at the square end opposite the MPPC so that γs entering the crystal traversed the 10mm long length. The output of the MPPC was input to a Canberra Model 2007B scintillation pre-amp. The pre-amp output was input to an Ortec 571 shaping amplifier which fed the Canberra 8706 ADC/Multiport MCA. The gain of the shaping amplifier was adjusted to get a peak signal of ~8V. The settings of the Ortec shaping amplifier were as follows:

1. Gain: fine = 1.0 course = 100 or 200 internal jumper = 0.1

2. Shaping time: 3μs

3. Positive input

4.Pole zero adjust mode

5. 2048 channels

The identification numbers of the sources are ^{137}Cs: ICN-375-126 and ^{22}Na: ISOP-MMS04-A19351. Source spectra were taken at various bias voltages using the ^{137}Cs source and at the suggested operating voltage of 70.3V using the ^{22}Na source.

Table 1. Summary of Energy Spectra Files

File	Main Peak Mean	Std. Deviation	Bias Voltage (v)	Ortec Course Gain
CS-137-01	1391.31 ± 0.44	78.82 ± 0.50	70.3	200
CS-137-02	1303.31 ± 0.30	79.56 ± 0.34	70.3	200
CS-137-03	649.96 ± 0.23	39.13 ±0.26	70.3	100
CS-137-04	494.82 ± 0.28	30.81 ± 0.32	70.1	100
CS-137-05	1007.00 ± 0.37	64.94 ± 0.42	70.1	200
CS-137-06	727.67 ± 0.39	49.85 ± 0.34	69.9	200
CS-137-07	849.78 ± 0.34	48.36 ± 0.38	70.5	100
CS-137-08	1086.94 ± 0.36	62.21 ± 0.41	70.7	100
CS-137-09	1392.08 ± 0.48	79.89 ± 0.54	70.9	100
CS-137-10	1576.66 ± 0.69	97.70 ± 0.77	71.0	100
NA-22-01	570.07 ± 0.28	42.70 ± 0.35	70.3	100
NA-22-02	1186.62 ± 0.69	91.00 ± 0.84	70.3	200

Results of Energy Spectra Measurement

Table I lists the file name, mean of main absorption peak, standard deviation of main peak, bias voltage, and Ortec course gain setting for each measurement. The fine gain and internal jumper setting for the Ortec shaping amplifier were unchanged throughout the measurement. An example spectrum for each type of source is shown in figure 1. At present the “plateau” extending beyond the main ^{22}Na peak is not understood. I note that both spectra show a broad low peak at about 500 counts. This may possibly be due to β decays in the LYSO crystal, but in any case seems to be a feature independent of the source. The mean value of the main source peak for ^{137}Cs is plotted versus the bias voltage of the MPPC in figure 2. As noted in the figure caption, the lowest bias voltage point was measured only with a shaping amplifier course gain of 200 and the plotted value is the measured mean of the peak divided by 2. The data points were fit to a parabola which is shown on the plot. The gain of the MPPC is expected to be linearly related to the bias voltage according to the Hamamatsu specification data sheet. The reason for the 2nd order term in the energy peak versus bias voltage is not understood at present. I note that the maximum useful bias voltage for MPPC 53 for this measurement is 71.0V. Above this the noise from random Geiger-mode breakdown becomes to large for a reliable measurement of the source peak.

Suggestions for Future Measurement

The energy peak versus bias voltage for the ^{22}Na source needs to also be measured and compared to the behavior of the ^{137}Cs measurement. Measurements with no source present need to be made to

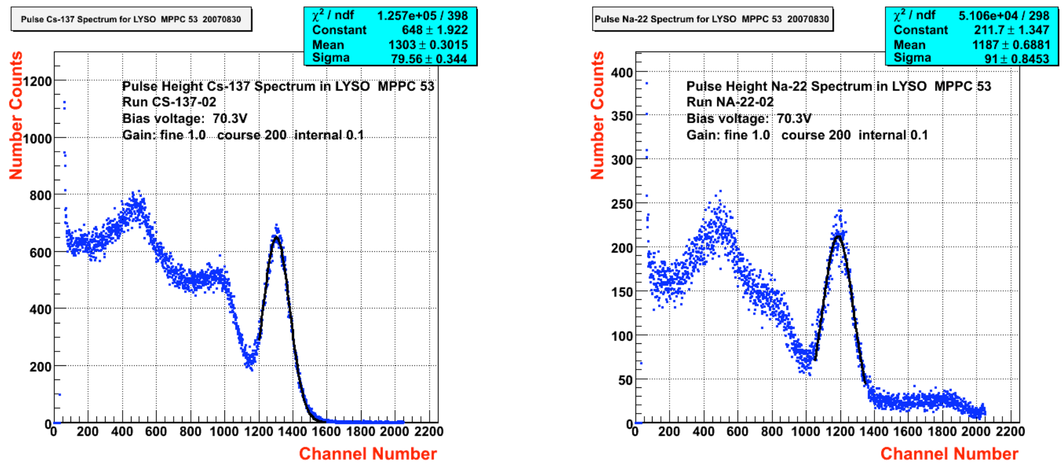

Figure 1. ^{137}Cs (left) and ^{22}Na (right) source spectra as recorded by the Canberra 8706 ADC/Multiport MCA. The shaping amplifier gain was the same for both spectra and is indicated on the figures. Fits shown are 3 parameter Gaussians: normalization, mean, and standard deviation. The ^{137}Cs data is from file CS-137-02 and the ^{22}Na data is from file NA-22-02.

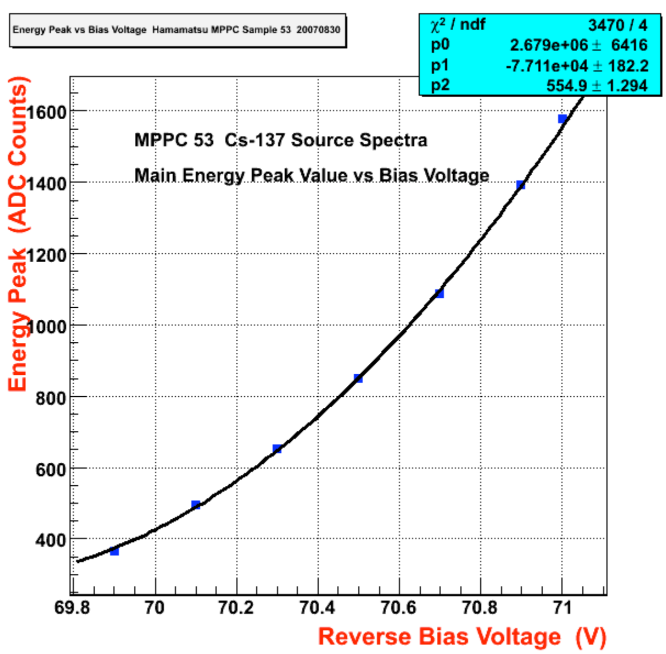

Figure 2. ^{137}Cs main peak versus MPPC53 bias voltage. All data except the point at bias voltage 69.9V were taken with course gain 100 on the shaping amplifier. The 69.9V point was taken with course gain 200 and the plotted peak mean is the fit value divided by 2. The solid line is a parabolic fit to the data.

better understand if the shape of the spectra outside the source main peak is related to the LYSO crystal characteristics, i.e. the β decay of the ^{176}Lu isotope in the crystal. Some calculation of the expected energy deposition in the crystal should help to clarify the features of the spectra. Use of a BGO crystal which has negligible residual radioactive isotopes might also help in understanding the background on which the main source peak sits.