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# Neutron Signal and Noise Separation of the $^6$Li-ZnS(Ag) scintillator (BC702) Using Flash ADC

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## 1. Introduction

Neutron total cross-sections have been measured by using the time-of-flight (TOF) method at Pohang Neutron Facility (PNF). A $^6$Li–ZnS(Ag) scintillator BC702 from Bicron (Newbury, OH) with a diameter of 127 mm and a thickness of 6.35 mm mounted on an EMI-93090 photomultiplier was used as a detector for the neutron TOF spectrum measurement [1]. This detector is sensitive to thermal and epithermal neutrons and insensitive to gamma radiation. However, it is required to more accurately separate neutron signal and noise.

In the present work, we studied neutron signal and noise separation of the BC702 scintillator to measure the accurate neutron TOF data. This study will apply to nuclear data experiments and improve the quality of nuclear data measured at PNF. We also briefly discuss the future plan to apply our research to different kinds of neutron detectors.


Figure.1: A photo of $^6$Li-ZnS(Ag) scintillator.

## 2. Experimental Method

Neutrons are generated from the water-cooled Ta target interacting with electron beam from PNF electron Linac. These neutrons path through the 11-m-long TOF path and counted on BC702 scintillator placed at the endpoint of the tube. The time and the shape of signal from the BC702 scintillator were fed into a 100 MHz 10-bit 8 channel flash ADC (NFADC 100, Notice Korea) as shown in Figure.2. 2 channels of FADC are used to take the trigger signal from the linac and neutron signal from BC702 scintillator both. Neutron TOF can be calculated by subtracting the time of linac trigger signal from time of neutron signal on the BC702 scintillator.

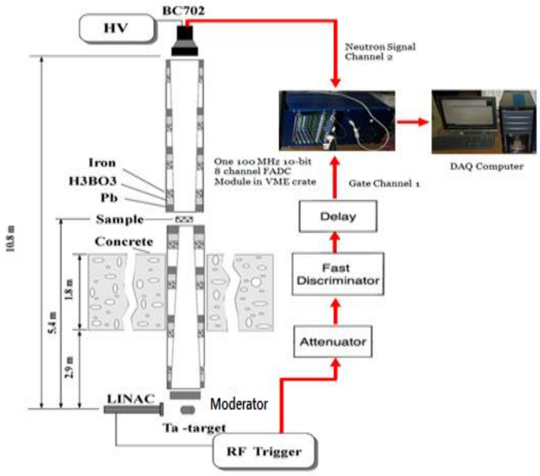



Figure.2: A schematic of neutron TOF DAQ system.

The shape and TOF of the neutron signals were scanned using ROOT code and were compared with those of noise. The neutron signals have bigger signal area than noise. Signals with small area are regarded as noise. And gamma flash signals which have different shape compared with general neutron signal of the big signal area in Figure.3 have short TOF. The gamma flash is also generated when electron beam interacts with Ta target. However, it is much faster than neutron. Therefore it has short TOF. The signal with short TOF is also regarded as noise.

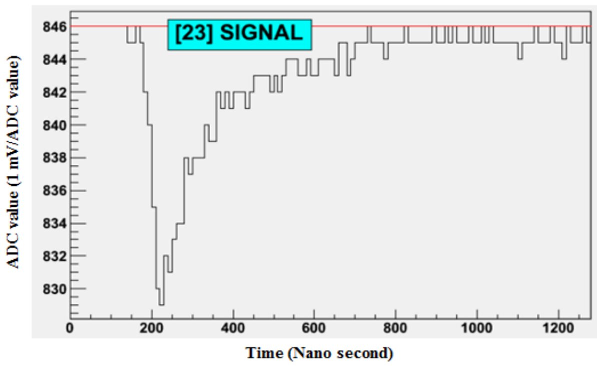


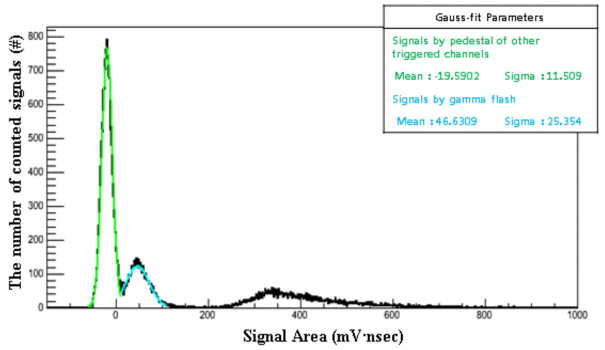

Figure.3: The shape of neutron signal from the $^6$Li–ZnS(Ag) scintillator.

## 3. Data Analysis and Result

The signals were integrated to get the signal area and they were drawn as histogram as shown in Figure.4 (a). It was gauss-fitted at the small signal area regions. There are two kinds of noise. One as pedestal is due to signal triggered by other devices connected to FADC and another one is noise by gamma flash. The former is gauss-fitted by blue line and the latter is gauss-fitted by green line. The mean and sigma of green line are 46.6309 and 25.354, respectively. The signals with less than 6 sigma (198.749) area from the mean value are considered as noise.

After subtracting the noises using the area, there are still noises which have big signal area. Therefore, they are separated through the analysis of the signal TOF. The neutron signals and noise was distinguished at 2.1698 μs of the TOF, which is also 6 sigma TOF value from the mean, as shown in figure.4 (b).

**(a)**




**(b)**

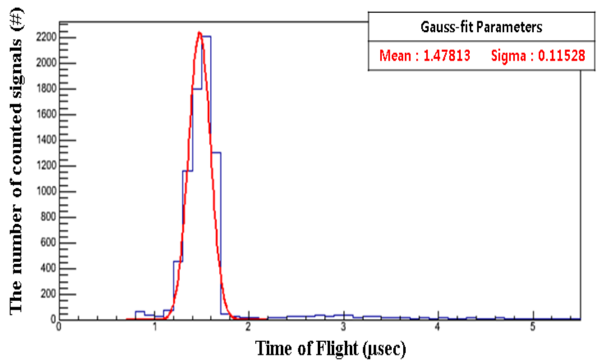



Figure.4: Gauss-fitted histograms as function of signal area (a) and time-of-flight (b).

## 4. Conclusion

The parameters to separate the neutron signals and noises of the 6Li− ZnS(Ag) scintillator are determined through the upper processes. Three kinds of noise are determined by the parameters as shown in figure.5. The signals at the green (pedestal), red (gamma flash), and blue (gamma flash with big signal area) region are subtracted from the total amount of the counted signals. These algorisms will be applied to next neutron TOF experiments.

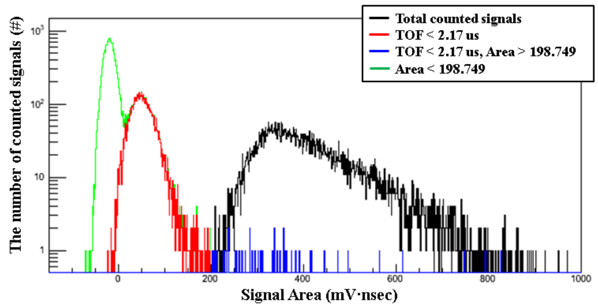



Figure.5: The number of counted signal as function of signal area.

Two additional neutron detectors will be introduced for neutron TOF experiment. These will measure the neutron flux to get the normalization factor. We will also conduct signal and noise separation of these neutron detectors

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