Neutron-gamma separation performance of PANDORA in SAMURAI30 experiment

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The neutron-gamma discrimination ability of PANDORA (Particle Analyzer Neutron Detector Of Real-time Acquisition)[1] was studied for SAMURAI 30[2,3] experiment using ^{11}Li(p,n) reactions.[4] The method of separating neutron and gamma events is based on charge integration, where the PSD (Pulse-Shape Discrimination) parameter is $(Q_{\rm Long}-Q_{\rm Short})/Q_{\rm Long}$, where $Q_{\rm Long}$ and $Q_{\rm Short}$ are derived from the charge integrated in the long gate and short gate of each end of a PANDORA bar, respectively. PSD$_{\rm mean}$ can be defined as the arithmetic average of PSD because PANDORA is a double-ended read-out. Figure 1 presents a two-dimensional plot of PSD$_{\rm mean}$ vs. $Q_{\rm Long}$(light output) of a PANDORA bar. The locus in the higher PSD region corresponds to the neutron-like events, while the distribution in the low PSD range represents the gamma-like events.

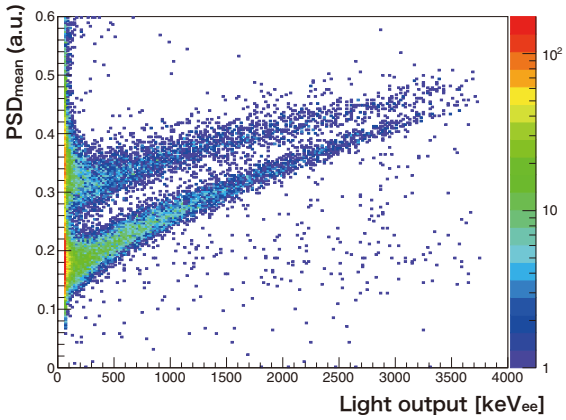

Fig. 1. PSD$_{\rm mean}$ as a function of light output (bar ID = 7).

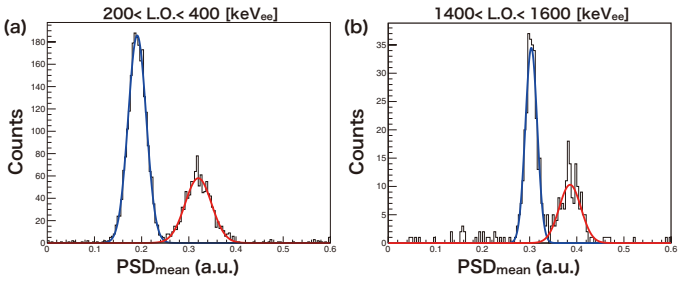

Fig. 2. PSD$_{\rm mean}$ distributions for the light output (a) from 200 to 400 and (b) from 1400 to 1600 [keVee]. The blue and red lines shows gamma and neutron events, respectively.

To evaluate the discrimination performance of PANDORA, Figure-of-Merit (FoM)is used. FoM is defined as:

$$\mathrm{FoM} = \frac{\Delta_{\gamma-n}}{L_{\gamma-\mathrm{FWHM}} + L_{n-\mathrm{FWHM}}}, \qquad (1)$$

where $\Delta_{\gamma-n}$ is the PSD difference between the neutron and gamma component peaks. $L_{\gamma-\mathrm{FWHM}}$ and $L_{n-\mathrm{FWHM}}$ are the full widths at half maxima of the gamma and neutron distributions, respectively. In this work, we used the window method, detailed in Ref. 1). Figure 2 shows the one-dimensional PSD$_{\rm mean}$ projections in 200 keV$_{ee}$ wide window centered at light outputs of 300 keV$_{ee}$ (a) and 1500 keV$_{ee}$ (b), respectively. The calculated FoM values are 1.17 ± 0.01 (a) and 0.98 ± 0.03(b).We achieved better FoM value than previous studies.[5–7] Owing to the optimized digital read-out, large gain setting, and improved scintillation material, we achieved better FoM value than previous studies.

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