Gain calibration of the PHENIX Shower Max Detector (SMD)

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In order to measure the energies and positions of very forward neutrons after proton-proton and heavy ion collision, Zero Degree Calorimeters (ZDCs) and Shower Max Detector (SMD) are located ±1800 cm away from the collision point.[1)] The SMD is composed of 7 vertical and 8 horizontal plastic scintillator stripes. The SMD measures the shower profile of high energy neutrons come from interaction point. The incident neutron position is reconstructed using following equation[1)]:

$$\text{Position} = \frac{\sum_{i=1}^{\#\text{hit SMD}} (\text{smd energy})_i \times (\text{smd position})_i}{\sum_i (\text{smd energy})_i}$$

where sum runs for number of hit SMD strips that have signals above the threshold and 'smd energy' is the observed energy in a given SMD strip, and 'smd position' is the center position of the corresponding strip. As the reconstructed position of an incident neutron is weighted by the energy deposit in the SMD strips, the gain of each strip should be matched in order to reconstruct the neutron position correctly.

The gain matching result for horizontal SMD strips is discussed in this report. Gain matching was carried out using a ^{60}Co source. ^{60}Co emits gamma-rays with decay energies of 1.173 or 1.332 MeV. The source rate was of a similar order of to that of the cosmic ray rates; thus, the cosmic backgrounds are subtracted from the ADC spectra in order to extract the ADC distribution from the source.

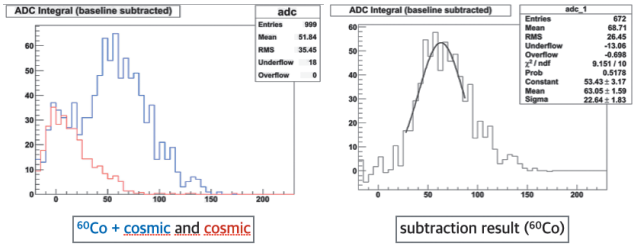

Fig. 1. Distributions of ADC data from ^{60}Co with cosmic rays (left) and ^{60}Co (right).

Figure 1 (left panel) shows the raw ADC spectra with/without a source. The right panel shows the extracted spectrum after the cosmic background subtraction. In order to quantify the gain, we attempted Gaussian fitting of the ADC peak. The model dependence of the fitting function was evaluated using different functions (Landau, and Landau + Gaussian).

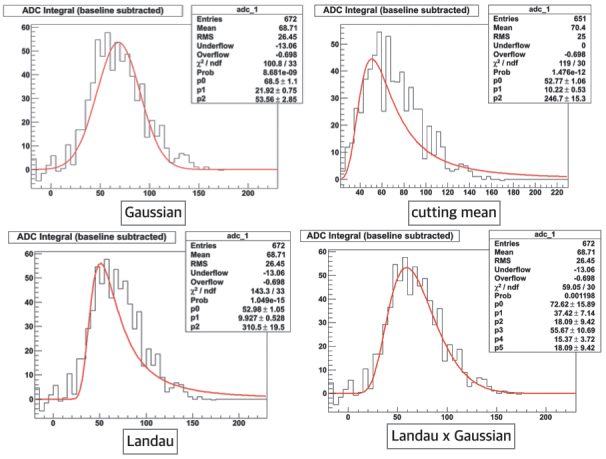

Fig. 2. Fitting results according to methods of mean calculation at detector 1.

Figure 2 shows four kinds of fitting for the same data. The 'cutting mean' excludes the low ADC region to minimize the effect of low statistics. The mean value estimated from the Gaussian fit gives the central value of the gain and the variation of different fits gives the systematic error.

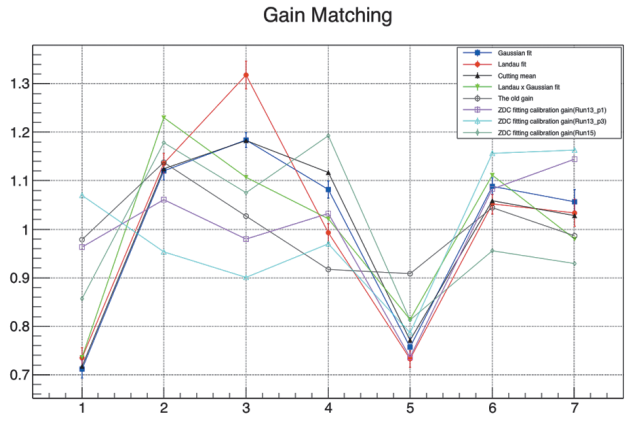

Fig. 3. Relative SMD gain according to calibration method.

The gain values obtained from different fits as well as the ones used for past analyses are plotted in Fig. 3. The resulting gain will then be determined by reconstructing the position distribution using real data.

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Reference

1) M. Kim, PHENIX analysis note 1246.