RESEARCH REPORT FOR RCNP 2016

(Experimental Nuclear Physics)

Development of New Calibration Method Using ^{24}Na Source For CANDLES

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CANDLES experiment at the Kamioka Underground Observatory is searching for neutrinoless double beta decay of ^{48}Ca which has highest Q-values (4.3 MeV) among all $\beta\beta$ isotopes. A precise energy calibration of CANDLES detectors at Q-value of ^{48}Ca is crucial for the identification of candidate 0νββ events. We have been using an ^{88}Y radioactive source that emits two γ-rays of 0.89 MeV and 1.84 MeV for CANDLES calibration. However, these γ-ray energies of ^{88}Y are not high enough for the Q-value region of ^{48}Ca (4.3 MeV). Therefore, we aim to develop a new calibration γ-ray source with higher γ-ray energies which is ^{24}Na source with two γ-rays 1.37 MeV and 2.75 MeV. The ^{24}Na source is produced by neutron activation ^{23}Na inside NaI(Tl) scintillation. When ^{24}Na is created in NaI(Tl) scintillation, all beta rays of ^{24}Na are absorbed in this NaI(Tl) scintillation, while the γ-rays mainly escape from the NaI(Tl) scintillation and were detected by the CANDLES detectors to calibrate energy. Therefore, we can take gamma spectrum of ^{24}Na by beta and gamma coincidence method. In this report, we will summarize the status of our experiment.

Our experiment is divided into two phases: phase I at Osaka University (commissioning) and phase II at Kamioka Underground Observatory (setup into CANDLES experiment).

In phase I, we measured the coincidence gamma spectrum of ^{24}Na source by a NaI(Tl) detector. A ^{252}Cf neutron source covered by paraffin for moderation of fast neutrons was used to irradiate the 2x2 inch NaI(Tl) detector as source. ^{24}Na spectrum is shown in figure 1. Then, we estimated the detection efficiency by GEANT 4. As a result, the ^{24}Na intensity was around 7 Bq. Based on this result, we optimized size and geometry of NaI(Tl) detector as ^{24}Na source for CANDLES calibration. Three 2x6 inch NaI(Tl) detectors are required to calibrate for CANDLES detectors. In addition to, we also optimized the neutron activation configuration for three NaI(Tl) detectors by using graphite as neutron reflection material combining with paraffin as moderation material. After these optimizations, we designed the delivery system for three NaI(Tl) detectors into CANDLES setup.

Currently, we are preparing for phase II which setup three NaI(Tl) detectors as ^{24}Na source into CANDLES experiment.

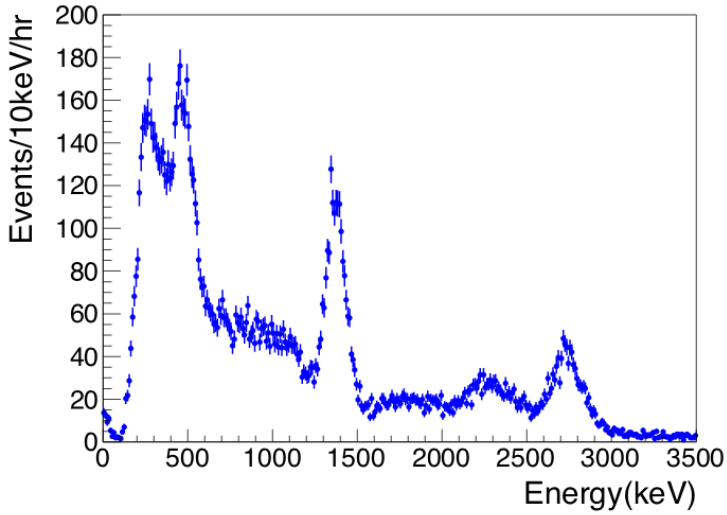

Figure 1. Gamma spectrum of ^{24}Na source by beta-gamma coincidence method