Study for Double Beta Decay of ^{48}Ca with CANDLES at Kamioka

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CANDLES is the project to search for neutrino-less double beta decay ($0\nu\beta\beta$) of ^{48}Ca. Measurement of $0\nu\beta\beta$ provides a test for the Majorana nature of neutrinos and gives an absolute scale of the effective neutrino mass. We installed the CANDLES III system, which contained 350 g of ^{48}Ca, at the Kamioka underground observatory. In this system, the 96 CaF_2 scintillators are immersed in liquid scintillator.

In 2012 we improved the CANDLES III system for a high sensitive measurement. In the CANDLES III system, the photomultiplier tubes had small photo-coverage by the photomultiplier tubes. In order to increase the photo-coverage by the photomultiplier tubes, the light-concentration system was set between the photomultiplier tubes and the liquid scintillator vessel. The light-concentration system is shown in figure 1-a). We checked the performance of the light-concentration system by using a reference CaF_2(pure), which has high radioactive contamination (U-chain : 60 mBq/kg). Figure 1-b) shows the energy spectra of the reference CaF_2(pure) with/without the light-concentration system. The position of the α peak is risen from 2500 ch region to 4700 ch region. We found that the light collection efficiency with the light-concentration system is 1.9 times larger than the one without the light-concentration system. This corresponds to 0.9 p.e./keV in the number of photo-electron and satisfies a requirement for the CANDLES III system.

Now we continue the $0\nu\beta\beta$ measurement adding improvements for the system. The expected sensitivity of the CANDLES III system is 0.5 eV for neutrino mass.

References

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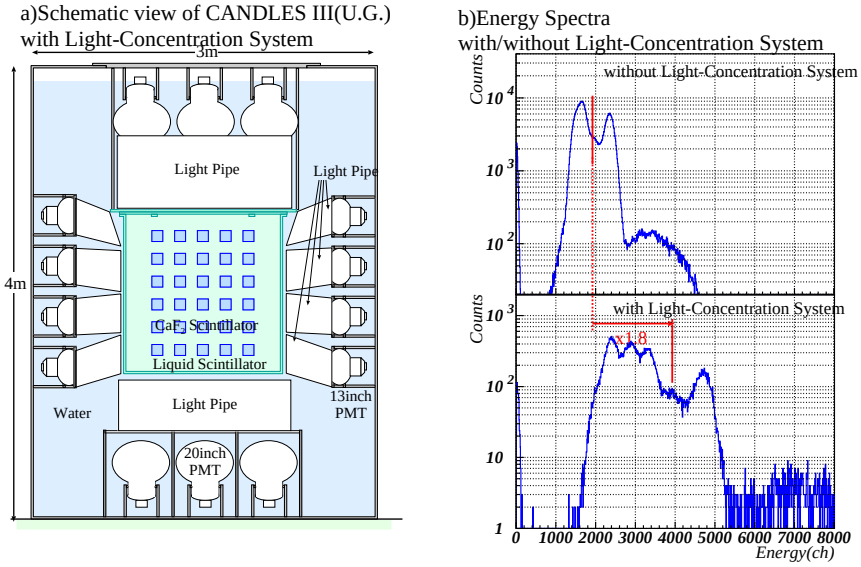

Figure 1: a) Schematic view of the CANDLES III system. The light-concentration system is set between the photomultiplier tubes and the liquid scintillator vessel. b)The energy spectrum without/with the light-concentration system. The light collection efficiency with the light-concentration system is 1.9 times larger than the one without the light-concentration system.