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Search for Neutrino-less Double Beta Decay with CANDLES

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CANDLES is the project to search for neutrino-less double beta decay ($0\nu\beta\beta$) of ^{48}Ca.
$0\nu\beta\beta$ is acquiring great interest after the confirmation of neutrino oscillation which demonstrated nonzero neutrino mass.
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.

In order to search for $0\nu\beta\beta$ of ^{48}Ca, we proposed CANDLES system by using CaF_2 scintillators.
The CANDLES system aims at a high sensitive measurement by a characteristic detector structure and ^{48}Ca enrichment.
The detector structure realizes a complete 4π active shield by immersion of the CaF_2 scintillators in liquid scintillator.
The active shield by the liquid scintillator leads to a low background condition for the measurement.
On the other band, ^{48}Ca enrichment is also effective for the high sensitive measurement, because natural abundance of ^{48}Ca is very low (0.19\%).
This means that an improvement of sensitivity by enrichment is a maximum of 20 times for the neutrino mass.
However ^{48}Ca enrichment is generally difficult and expensive.
Therefore we started the study of ^{48}Ca enrichment and succeeded in obtaining enriched ^{48}Ca although it is a small amount.

We have developed the CANDLES III system, which contained 350 g of ^{48}Ca without enrichment, at the Kamioka underground laboratory.
In 2012 we installed a light-concentration system in the CANDLES III system in order to improve a energy resolution.
A photo-coverage was about twice larger than the one without the light-concentration system.
And we started a $0\nu\beta\beta$ measurement and have data of a measurement time for 3 months.

Here we will report the detector performance for background rejection, the result of the measurement and the expected sensitivity with the light-concentration system.

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