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Development of CANDLES detector to search for neutrinoless double beta decay of 48Ca

The observation of neutrino-less double beta decay (0nbb) would be one of the most realistic way to prove the Majorana nature of the neutrino and lepton number violation. CANDLES studies 48Ca double beta decay using CaF2 scintillator. The main advantage of 48Ca is that it has the highest Q-value (4.3 MeV) among all the isotope candidates for 0nbb. In principle, it enables us to measure signals in region with very low background condition.

The CANDLES III detector is currently operating with 300kg CaF2 crystals in the Kamioka underground observatory, Japan. The detector consists of 96 pure CaF2 crystals immersed in liquid scintillator for an active shield. Sensitivity for 0nbb half-life obtained from 60 days data in 2013 was > 0.8 × 10ˆ22 year. In 2014, a cooling system and a magnetic cancellation coil were installed with the aim to increase light emission of CaF2 and collection efficiency of the photo-multipliers. After this upgrades, light yield was increased to 1000 p.e./MeV which is 1.7 times larger than before.

We report on detector performance and stability improvements by upgrades, obtained from analyzing commissioning run data. In addition, we present a plan for future detector upgrades in 2015. Upgrading by installing neutron and gamma-ray shields to reduce the remaining backgrounds is expected to increases our sensitivity to > 10ˆ23 year. We also report the future development of the next generation detector, CaF2 scintillating bolometer.

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