Two Neutrino Double Beta Decay of ^{48}Ca by ELEGANT VI

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We studied the double beta decays of ^{48}Ca by means of ELEGANT VI[1] with CaF_2(Eu) scintillators. ^{48}Ca has the lagest $Q_{\beta\beta}$-value 4.27MeV among $\beta\beta$ decay nuclei. The least background rate is expected around the $Q_{\beta\beta}$-value because the $Q_{\beta\beta}$-value is larger than the end point of natural background γ-ray energy. For first result by the low background measurement, we found the most stringent limit for neutrinoless double beta decay($0\nu\beta\beta$) of ^{48}Ca[2]. However, there are no significant two neutrino double beta decay counts.
In order to find the finite half-life of $2\nu\beta\beta$, we studied background origin by several analyses for ELEGANT VI. And we has reached the conclusion that contaminations in CaF_2(Eu) crystal itself are the background origin.
Radioactive contaminants in the CaF_2(Eu) are mostly composed of U- and Th-chain isotopes. $^{214}\mathrm{Bi}\xrightarrow[\beta]{}{}^{214}\mathrm{Po}\xrightarrow[\alpha]{}{}^{210}\mathrm{Pb}$ (U-chain) and $^{212}\mathrm{Bi}\xrightarrow[\beta]{}{}^{212}\mathrm{Po}\xrightarrow[\alpha]{}{}^{208}\mathrm{Pb}$ (Th-chain) are especially the serious background origin. These Po nuclei decay with short half-life ($T_{1/2}$ = 164μsec(^{214}Po) and 0.296μsec(^{212}Po)) and CaF_2(Eu) has long decay constant(0.9μsec). Thus radiations that emitted by the two consecutive decays are measured as the one event in CaF_2(Eu). Energy deposits by the consecutive decays in CaF_2(Eu) are E_{max} = 5.23MeV(^{214}Bi decay) and 4.48MeV(^{212}Bi decay). This means that contribution from these nuclei in interested energy window is the serious background. We estimated that the background contribution from the nuclei is 99% of a number of total events in double beta decays energy region(3-4.5MeV).
For the consecutive decay rejection we used 100MHz FADC(Flash ADC). This time bin 10nsec is a short period compared with the half-lives of the Po nuclei and we can observe $>$ 85% discrimination of the decays. Thus this step is the effective ways to extract such characteristic decays. We picked out such the decays and background rate at the energy region was improved by one orders of magnitude to the previous result. We will obtain the more accurate half-life of $2\nu\beta\beta$ for one year measurement.

References

[1] R. Hazama et al., Proc. Weak and Electromagnetic Interactions in Nuclei(WEIN 95), Osaka, June 1995, World Scientific, 635.
[2] I. Ogawa et al., contribution to this conference.