Research of shielding effect in MOON by GEANT4

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MOON (Molybdenum Observatory Of Neutrinos) is a hybrid double beta decay ($\beta\beta$) and solar ν detector with sensitivity to majorana mass of the order of $< m_\nu >\sim 0.03$eV as well as capability of charged-current neutrino spectroscopy of low energy solar ν's down to 168keV. To detect $\beta\beta$ decay and solar ν,it is important for new particle physics beyond the Standard Model (SM)[1][2][3].

The fine localization in time and in space is crucial for reducing background (BG) rates in realistic detectors. To reduce BG effectively, characteristic of BG and shielding materials is needed to understand and to select the best shielding materials and the best location of shielding materials.

In the present work, shielding effect for high energy γ rays and thermal neutrons with various shielding material and thickness were evaluated by GEANT4. And the best selection of shielding material was discussed for MOON.

The BG posed problems are divided into external sources and internal sources. The internal sources are radioactive contaminants (U,Th-chain) in the detector, the external sources are high energy γ rays and thermal neutrons from surrounding material. The high energy γ rays make continuum spectrum of Compton scattering at low energy range. Radioisotopes made by thermal neutrons emit serious BG radiation. In the present work, the shielding effect to external BGs were due to estimated at various energy range for $0\nu\beta\beta$ decay of ^{100}Mo (3.034MeV) and *pp* neutrino ($\leq$225keV), γ rays of ^{208}Tl (2.614MeV) and γ ray (2.225MeV) emitted by thermal neutron capture of ^{1}H.

A ^{nat}Ge detector whose dimension was 2inch in diameter and 2inch in length was put at the center of a shield. The shielding material, which was made of Pb or H_2O. Between the shielding material and the detector, air was filled. The out of detector system was filled with air[?]. The radiation sources were γ ray of ^{208}Tl (2.614MeV) and thermal neutron of 0.025eV. These radiations were emitted isotropic in direction from at the point which was 2.1m apart from the center of the detector. the simulation was performed one million events for each condition.

Since the shielding effect changes by a difference of material density, the thickness of the shielding material was normalized by its density in order to compare the shielding effect between Pb and H_2O.

The result of shielding effect for high energy γ rays was analyzed. At γ rays of ^{208}Tl (2.614MeV), Pb and H_2O was found to have the almost the same shielding effect. On the other hand, as it was shown in Fig:1, in the low energy range of *pp* neutrino ($\leq$225keV), a remarkable difference of shielding effect between Pb and H_2O was found. Pb was better shielding material than H_2O.

The effect for thermal neutron, the 2.225MeV γ ray due to the neutron capture of ^{1}H had obviously no effect to the energy range of $0\nu\beta\beta$ decay of ^{100}Mo (3.034MeV). On the other

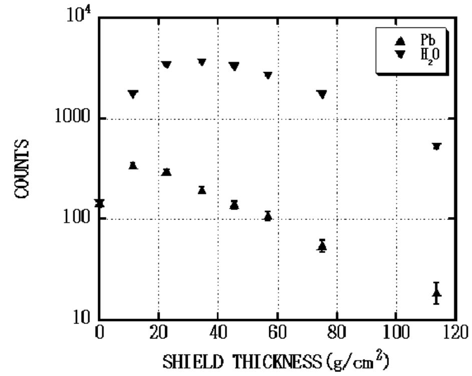

Figure 1: The shielding effect for the γ rays of ^{208}Tl (2.614MeV) using Pb (opened circle) and H_2O (closed circle) as shielding material at low energy range($\leq$225keV).

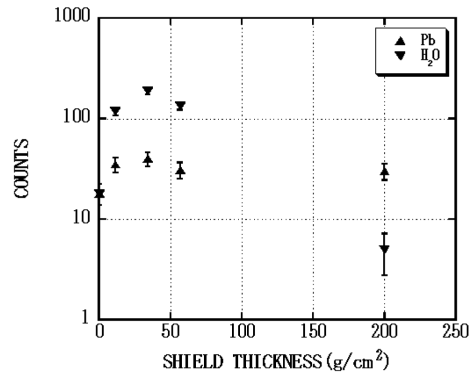

Figure 2: The shielding effect for thermal neutrons using Pb (opened circle) or H_2O (closed circle) as shielding material at low energy range ($\leq$225keV).

hand, it was shown in Fig:2, at low energy range of *pp* neutrino ($\leq$225keV), a remarkable difference of shielding effect between Pb and H_2O was found, Pb is better shielding material than H_2O.

In the present work, shielding effect was investigated for a high energy γ ray and a thermal neutron in MOON. As a result, shielding effect for high energy γ rays and thermal neutrons using Pb or H_2O is the almost same around $0\nu\beta\beta$ decay of ^{100}Mo (3.034MeV). However, the overs effect for high energy γ rays and thermal neutrons using Pb is better than H_2O at low energy range of *pp* neutrino ($\leq$225keV). Therefore Pb was found to be the suitable shielding material in MOON.

References

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