PROCEEDINGS OF SCIENCE

Future XMASS project

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XMASS is a single phase liquid xenon detector. It is designed for a program of physics targets. The present XMASS-I detector targets direct dark matter detection. Background rejection is based on position information. Due to strong stopping power of xenon, beta and gamma rays from the outside cannot penetrate deep into the liquid xenon. By eliminating event interacting outer region, most background can be eliminated.

By using the data obtained by XMASS-I, dark matter, axion and double electron capture searches were carried out and the results were published.

XMASS-1.5 is next step of XMASS project to perform dark matter search with higher sensitivity. Detector design is now ongoing to improve sensitivity below 10^{-46}cm^2 cross section for 100GeV WIMP by increasing total amount of liquid xenon and reducing background level below 10^{-5} /day/kg/keVee.

PMT exchange for surface background reduction is one of the largest modification from XMASS-I. New PMT R13111 has dome-shaped photocathode which is very effective for identification of surface background. Confirmation of performances including sensitivity of side part of photocathode is already done. Radioactivity reduction of R13111 is ongoing by screening all parts. Up to the present, reductions of ~1/3 for U chain(^{226}Ra) and Th chain, <1/8 for ^{40}K and ~1/6 for ^{60}Co from XMASS-I PMT are achieved.

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1.Introduction

XMASS [1] is a single phase liquid xenon scintillation detector. It is designed to achieve a range of physics goals as the program develops: dark matter, neutrinoless double beta decay and ^{7}Be/pp solar neutrinos. The present XMASS-I detector is the first step in the project and targets direct dark matter detection with 832 kg of liquid xenon in its sensitive volume. The experiment is located in the Kamioka Mine under Mt. Ikenoyama in Japan, which provides 2700 m water equivalent in shielding from cosmic rays.

1.1XMASS-I detector

Figure 1 shows the XMASS-I detector. The sensitive region of XMASS-I, an approximation to a sphere of about 80 cm diameter, is surrounded by 642 PMTs. In order to reduce external gammas, neutrons, and cosmic-ray muon induced backgrounds, the detector is placed at the center of a water tank. The tank is 10 m in diameter and 10 m high. 72 20-inch PMTs (Hamamatsu R3600) inside the water tank provide an active muon veto. Further background rejection is done by usign event position information. Due to the strong stopping power of xenon, beta and gamma rays from the outside cannot penetrate deep into the liquid xenon. By eliminating events interacting in the outer region, most of the background can be eliminated. More details are described in Ref. [2]. By using the data obtained by XMASS-I, dark matter, axion and double electron capture searches were carried out and the results were published [3-8].

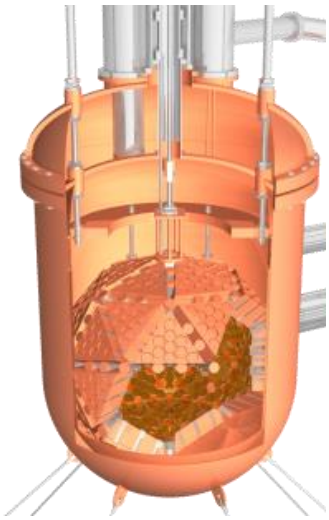


Figure 1: XMASS-I detector

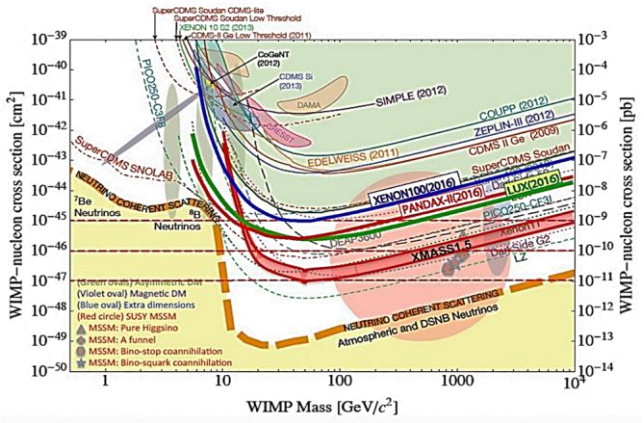


Figure 2: Expected sensitivity for WIMP dark matter.

2.XMASS-1.5, Next step of XMASS project

XMASS-1.5 is next step of XMASS project to perform dark matter search with higher sensitivity. Detector design is now ongoing to realize sensitivity below 10^{-46}cm^2 cross section for 100GeV WIMP (figure 2) by increasing total amount of liquid xenon to 5 tons and reducing background level below 10^{-5} /day/kg/keVee.

One of the largest modification from XMASS-I is PMT. Photocathode shape of PMT is changed from flat to dome-shape. Surface events which is one of the largest background can be identified very effectively by this dome-shape photocathode as shown in figure 3. R13111 is newly developed 3-inch dome-shaped photocathode PMT for XMASS-1.5. Performance check was already done for the first batch. Besides basic properties such as low dark rate and stable operation inside liquid xenon, sensitivity of side part of photocathode which is most important for surface background reduction is confirmed as designed level, larger than 80% of sensitivity at dome top. Radioactivity reduction

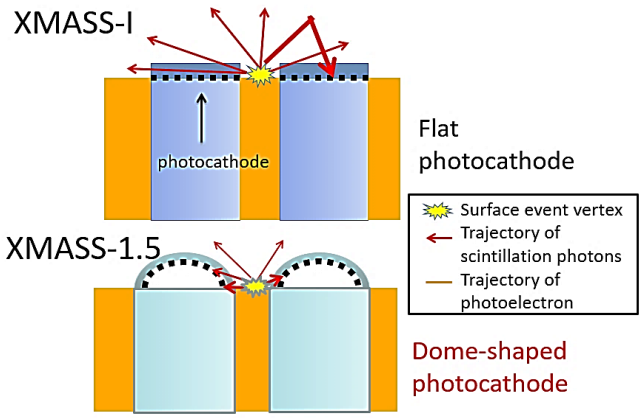
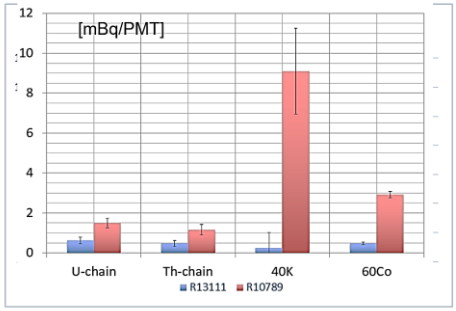


Figure 2: PMTs used in XMASS-I and XMASS-1.5



[mBq/PMT]	U chain	Th chain	40K	60Co
Target value	0.15		1.00	0.30
R13111	0.624±0.168	0.478±0.152	<1.24	0.478±0.0567
R10789	1.51±0.243	1.16±0.27	9.10±2.15	2.92±0.161

Figure 3: Radioactivity of R13111(XMASS-1.5) and R10789(XMASS-I).

for PMT is ongoing by screening all parts. 1/10 of R10789 used in XMASS-I is set as target value to realize 10^{-5} /day/kg/keV$_{ee}$ level of background. Figure 4 shows achieved radioactivity for R13111 comparing to R10789. Current achieved reduction from R10789 is ~1/3 for U/Th chain, <1/8 for ^{40}K and ~1/6 for ^{60}Co.

3.Summary

XMASS is a single phase liquid xenon detector. XMASS-1.5 is next step of XMASS project to achieve sensitivity below 10^{-46}cm^2 cross section for 100GeV WIMP dark matter. PMT exchange for surface background reduction is one of ther largest modification from XMASS-I. Dome-shaped photocathode of new PMT R13111 is very effective for indentification of surface backgroud. Confirmation of performance including sensitivity of side part of photocathode was already done. Ongoing radioactivity reduction of R13111 achieved ~1/3 for U chain (^{226}Ra) and Th chain, <1/8 for ^{40}K and ~1/6 for ^{60}Co from XMASS-I PMT up to the present.

References

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