LIQUID XENON PURIFICATION STUDIES FOR THE MEG ($\mu \rightarrow e\gamma$) PHOTON CALORIMETER

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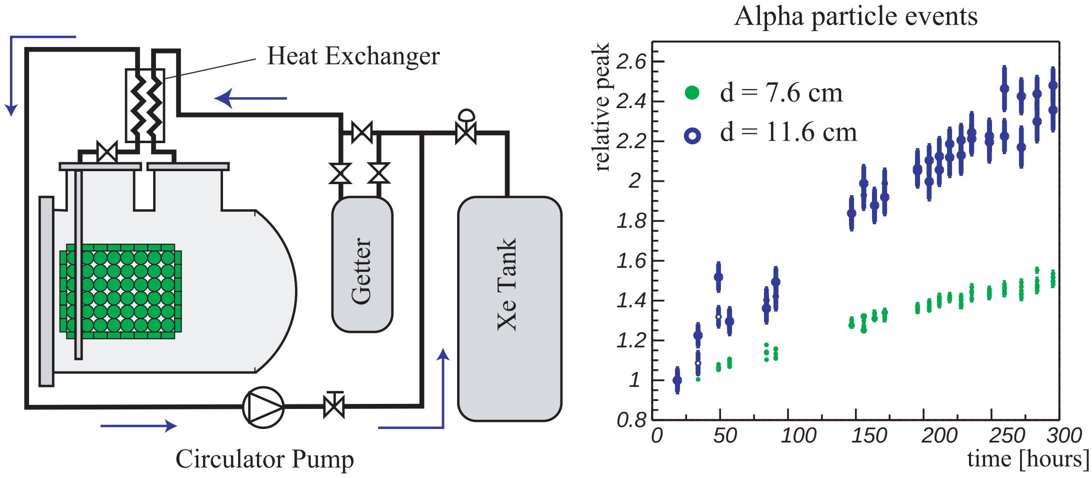

Figure 1: *Schematic diagram of the purification system (left). Change in light yield observed by the PMTs for alpha events (right). The data shown are normalized to the initial points of each data set. As can be seen from the plot, the light yield increases as the purification process advances and λ_{abs} increases, yielding a steeper rise for the far PMTs compared to the closer ones, as expected.*

We have conducted a basic study of the liquid xenon photon detector by using a large prototype version. The large prototype consists of several cryogenic components such as a cooling refrigerator as well as an array of 228 photomultipliers (PMTs) placed in ~100 liters of liquid xenon. To date the operative cycle of the large prototype has been repeated several times and a long term stability has been achieved by using a pulse tube refrigerator for liquefying and recondensing the xenon[1]. Characteristic features of the detector have been investigated with cosmic rays, α particles, and gamma and electron beams. Among these features the absorption length (λ_{abs}) of the scintillation light in liquid xenon is the most important. Obtaining a sufficiently long λ_{abs} ($>$ 1m) is a prerequisite in order to achieve the required detector resolution. Scintillation light can be absorbed by water or oxygen molecules if they exist in the liquid, resulting in a prohibitively short λ_{abs}. Consequently, it is essential to reduce the impurities to below the ppm level.

To this purpose a purification system was introduced in the large prototype as shown in Figure 1(left) . Purification of the stored xenon was performed by circulating this through a metal-getter purifier. A typical xenon circulation rate was about 10 ml/min (liquid equivalent) and was controlled by a valve close to the diaphragm pump. Figure 1(right) shows the change in light yield for alpha events, observed by PMTs located at 7.6 cm and 11.6 cm from an ^{241}Am alpha source. A similar light yield change was observed for cosmic-ray events recorded during the purification process. From comparison to Monte Carlo simulations it can be reasonably concluded that a $\lambda_{abs} \geq$ 1 m is achieved after 800 hours of purification. In the present purification scheme liquid xenon is made gaseous in the heat exchanger and liquefied again in the chamber after having passed through the purifier. Currently this limits the speed of circulation. In order to improve the purification performance we are planing to use another method which utilizes a low-temperature fluid pump for liquid circulation and a cell filled with molecular sieves as an impurity removal device. This method would have the advantage that we do not need to re-liquefy xenon, and can thus expect a higher circulation speed, of the order of several tens of liters per hour. R&D work on the new system has started.

REFERENCES

[1] T. Haruyama et al., KEK Preprint 2002-102, September (2002).