PROCEEDINGS OF SCIENCE

Performance of the KOTO Sampling Calorimeter

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The J-PARC KOTO experiment is to search for the $K_L \to \pi^0 \nu \bar{\nu}$ decay which is sensitive to New Physics. A main feature of the signal is that only two photons and nothing elseare observed in a hermetic detector system. Thus, it is important to detect all decay particles from the K_L decay. A 5.5-m long cylindrical Lead/Scintillator sandwich sampling calorimeter surrounds the fiducial K_L decay region to detect extra photons. The detection efficiency of the sampling calorimeter is designed to meet with the background elimination capability. We present the performance of the sampling calorimeter using tagged photons by the $K_L \to 3\pi^0$ decay. In particluar, the performance of a new sampling calorimeter installed in 2016 is reported.

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1. KOTO Experiment

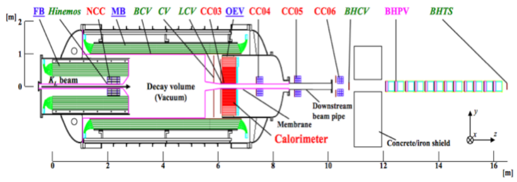

Figure 1: Cut-out-view of the KOTO detector in the physics run in 2015.

The KOTO Experiment [1] is to search for the are K_L decay $K_L \to \pi^0 \nu \bar{\nu}$. The Standard Model predicts the branching ratio to be $(3.0 \pm 0.3) \times 10^{-11}$. Because this decay is highly suppressed in the Standard Model, the decay is a good probe to explore New Physics. Observables from $K_L \to \pi^0 \nu \bar{\nu}$ decay are only two photons and nothing else. The CsI calorimeter is to measure the energies and positions of two photons, and hermatic veto counters are to ensure nothing else exists.

2. The Perforamce of The Photon Veto Counter

THe photon veto counter, surrounding the K_L decay region is to capture extra photons. The radiation length is $18.5X_0$ due to the alternative structure of 1(or 2) mm Pb sheets and 5 mm scintillators. Additional counter, the Inner Barrel(IB) were installed inside the Main Barrel(MB in Figure 1) to detect photons from the $K_L \to \pi^0 \pi^0$ decay with the inefficiency three-times smaller.

The performance of the new counters has been measured using tagged photons. The energy and direction of photons going to the barrel region are reconstruted with five photons which are measured by the CsI calorimeter under the assumption that six photons come from the $K_L \to 3\pi^0$ decay. Using five photons detected in the calorimter, two π^0 are reconstructed to identify the decay vertex of K_L. The opening angle of the fifth photon and photon going to the barrel region is obtained. With the π^0 mass constraint, the energy of the photon is estimated.

The time of flight to the CsI calorimeter or the to barrel region calculated for six photons is used to calibrate the timing of the the new counters. By comparing the time of flight of six photons with respect to energy deposited in the new counters, the timing resoultion of the Counters is also estimated.

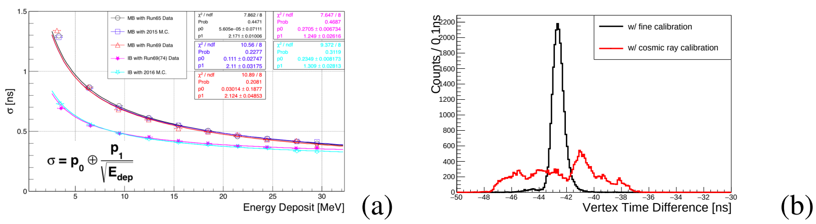

Figure 2: (a) Timing resolution of IB and MB. IB provide 1.5 times better timing resolution. (b) Timing caliration using K_L data(black line) and cosmic data(red line).

References

[1] J. K. Ahn et al., (J-PARC KOTO Collaboration), PTEP, 2017, 021C01 (2017).

[2]