PROCEEDINGS OF SCIENCE

Performance of the KOTO Sampling Calorimeter

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The J-PARC KOTO experiment is searching 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 are observed in a hermetic detector system. Therefore, 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 photons exiting the region. The detection efficiency of the sampling calorimeter is designed to meet with the background elimination capability. We will present the performance of the sampling calorimeter using tagged photons by the $K_L \to 3\pi^0$ decay. Especially, the performance of a new sampling calorimeter installed in 2016 will be reported.

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[†]A footnote may follow.

1. KOTO Experiment

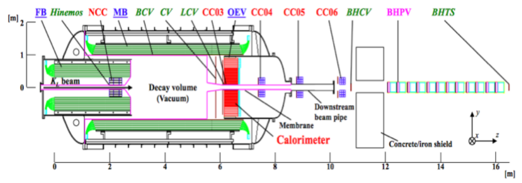

Figure 1: Cut-out-view of the KOTO detector in the physics run in 2015.

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

2. Measuring Perforamce of Photon Veto Counter

Photon Veto Counter in fiducial direction is installed to capture photons exiting the decay region. The radiation length of the Counter is $18.5X_0$ thanks to their alternative structure of 1(or 2) mm Pb sheets and 5 mm scintillators. Additional Counter is installed inside Main Barrel(MB in Figure 1) to count photons from $K_L \to \pi^0 \pi^0$ decay a factor of 3 times better.

Performance of the Counter has been measured using identified photons. Energy and direction of photons going to the Counter are reconstruted with five photons which are detected by CsI Calorimeter under the assumption that six photons come from $K_L \to 3\pi^0$ decay. Using five photons detected by CsI Calorimter, two π^0 are reconstructed to estimate vertex of K_L. Finally, the opening angle of fifth photon and photon going to the Counter is obtained. With the π^0 mass constraint, the energy of photon is calculated.

Perforamce of the Counter is evaluated in all reconstructed $K_L \to 3\pi^0$ decay systems. The time of flight to the CsI calorimeter or the Counter calculated for six gammas is used to calibrate the timing of the the Counter because gamma-deteced time subtracted by time of flight should be same as decay time of K_L. By checking this difference with respect to energy deposited on the Counters, timing resoultion of the Counters is also estimated.

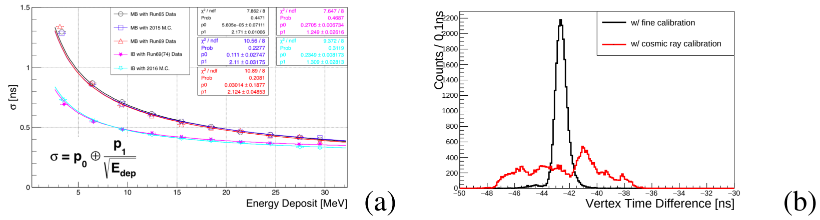

Figure 2: (a) The timing resolution of MB and (IB)Inner Barrel. IB provide 1.5 times better timing resolution. (b) Result of timing caliration using K_L data(black line) and cosmic data(red line)

References

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