Measurement of the K_L^0 yield at the K_L^0 beam line newly built at J-PARC

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The K$^{\rm O}$TO experiment aims to discover the decay $K_L^0 \to \pi^0 \nu\bar{\nu}$ at the J-PARC 30 GeV proton synchrotron. Because its theoretical uncertainty is small, this decay mode is a powerful tool to measure SM parameters and search for new physics beyond the SM. In order to achieve the SM level sensitivity, a high intensity K_L^0 beam is required. We constructed a new K_L^0 beam line at J-PARC by summer 2009 and carried out a beam survey experiment from November 2009 to February 2010. In this experiment, we measured the K_L^0 yield with hodoscopes and small size electro-magnetic calorimeters. We report the techniques and results of the measurement.

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The E14 K^{O}TO experiment at J-PARC is designed to discover the $K_L^0 \to \pi^0 \nu \bar{\nu}$ decay. Since the theoretical uncertainty in the branching ratio is small(1-2%), it provides a good testing ground of the SM and beyond[1]. The branching ratio, Br($K_L^0 \to \pi^0 \nu \bar{\nu}$), is predicted to be $(2.49 \pm 0.39) \times 10^{-11}$ in the SM[2]. In order to achieve the SM sensitivity for $K_L^0 \to \pi^0 \nu \bar{\nu}$, the flux of K_L^0 has to be large. We constructed a new K_L^0 beam line at J-PARC and carried out a beam survey experiment, in which we measured the K_L^0 yield and other properties of the beam line, from November 2009 to February 2010. We used two kinds of production targets; $0.36\lambda_I$ long Ni and $0.68\lambda_I$ long Pt. The neutral kaon's produced in the target were extracted at 16° with respected to the primary proton beam. We used the $K_L^0 \to \pi^+ \pi^- \pi^0$ decay to measure the K_L^0 yield. The detection system consisted of hodoscopes and electro-magnetic calorimeters. The directions and positions of π^+ and π^- were measured by two layers of hodoscopes, each of which consisted of 1cm wide plastic-scintillator bars. The energies and positions of two photons from the π^0 decay were measured by two sets of 35cm $\times$ 35cm $\times$ 30cm electro-magnetic calorimeters, each made of 25 undoped CsI crystals. All kinematic parameters can be solved by assuming momentum balance in the transverse direction, because the K_L^0 beam is narrow (it's solid angle is 7.8μSr) The $K_L^0 \to \pi^+ \pi^- \pi^0$ decays were identified by requiring that the invariant mass of two γ's is equal to the π^0 mass and the invariant mass of the π^+, π^- and π^0 is equal to the K_L^0 mass. The reconstructed π^0 mass and K_L^0 mass can be identified in Fig. 1 and Fig. 2, respectively. In order to calculate the K_L^0 yield, we estimated the contamination of background events, signal acceptance, and systematic errors for each target using Monte Carlo simulations; the contamination of background events was found to be a few percent in both cases. The flux of K_L^0 (preliminary) was measured to be $(1.83 \pm 0.038 \pm 0.13) \times 10^7 / 2 \times 10^{14}$ p.o.t. for the Ni target and $(3.73 \pm 0.080 \pm 0.25) \times 10^7 / 2 \times 10^{14}$ p.o.t. for the Pt target. The first uncertainty is statistical and the second one is systematic. We also measured the K_L^0 momentum distribution at 20m from the target, as shown in Fig. 3.

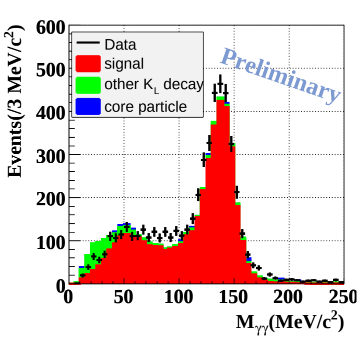

Figure 1: Invariant mass distribution of two γ's.

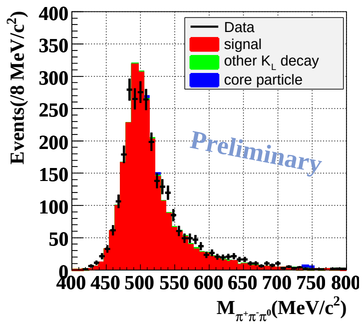

Figure 2: Invariant mass distribution of the π^+, π^- and π^0.

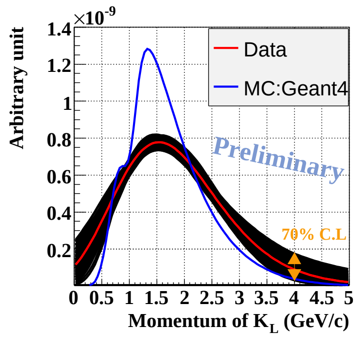

Figure 3: K_L^0 momentum distribution at 20m from the target.

References

[1] L. S. Littenberg, Phys. Rev. D **39**, 3322 (1989).

[2] F.Mescia and C. Smidth, Phys. Rev. D **76**, 034017 (2007).