T476 report

A study of the fine segmented liquid scintillator detector
with wave-length shifting fiber readout for K2K upgrade

T. Nakaya, I. Kato, H. Maesaka, K. Nishikawa (Kyoto U.); T. Kobayashi (KEK)

A primary purpose of T476 experiment is to study basic performance of a fine segmented liquid scintillator detector with wave-length shifting (WLS) fiber readout. The detector is a possible candidate of a neutrino detector in K2K experiment with following advantages:

- With liquid scintillator, a large full-active detector can be built inexpensively. In addition, an uniform response of each segment in the detector is expected.
- By using WLS fiber readout, the light correction from a large volume of the detector can be lead to small area of photo-detectors with high efficiency.
- A recent development of a multi-anode PMT makes it possible to read out many channels inexpensively, and to provide the precise measurement of the light yield.

Recently, such a detector is also studied at CERN [1].

The schematic picture of the detector is shown in Figure 1. The liquid scintillators, ELJEN EJ399-04 and Bicron BC517L were tested, both of which are proved not to attack a plastic fiber chemically. The liquid scintillator container was optically segmented by Aluminum cells ($2 \times 2 \times 20$ cm^3), each of which was read out by two 1mm ϕ WLS fibers. The two fibers were attached to one multi-anode PMT channel, Hamamatsu H6568-10. The detector can measure the track of a particle with energy deposit in each cell. With the fine granularity of the cell size, the detector had the fine tracking capability. As a consequence of the energy measurement, we proved that the detector can distinguish a proton track from a pion one by dE/dx as shown in Figure 2. The positive identification of a proton is crucial as a neutrino detector to select quasi-elastic interaction. Separately, we also measure the attenuation length of the fiber with a different detector setup which had $2.6 \times 2.6 \times 300$ cm^3 cell size.

The results of T476 experiment [2] are:

- Light yield of EJ399-04 for one 2×2 cm^2 cell with two fibers is measured to be 33 ± 2 photo-electrons for minimum ionized particles and 47 ± 3 for 1 GeV/c protons.
- With dE/dx measurement, we proved the performance to identify a proton track with the momentum between 0.6 and 1.2 GeV/c. The probability that a pion is misidentified as a proton is measured to be 3%.
- The attenuation length of the fiber in the liquid scintillator was measured to be 304 ± 1 cm.

T476 experiment is very successful and the new detector technology investigated here is promising as a new neutrino detector. Currently, based on T476 measurement, the K2K detector update is intensively designed, developed, and carried out.

References

[1] M. Doucet *et al.*, *Nucl. Instr. and meth.* **A459**, 459 (2000).
M. Doucet *et al.*, *Nucl. Instr. and meth.* **A453**, 545 (2000).

[2] I. Kato, master thesis, 'Kyoto University' (2001), unpublished

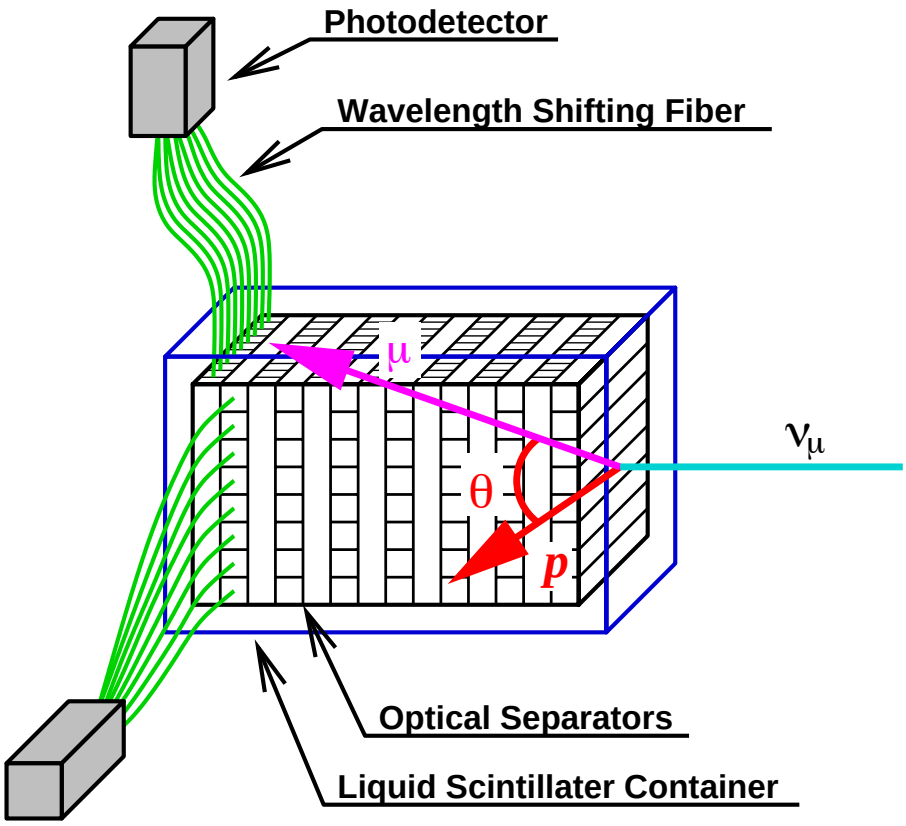

Figure 1: A schematic picture of the fine segmented liquid scintillator detector. The incident particle in T476 is a charged particle, either a pion or a proton.

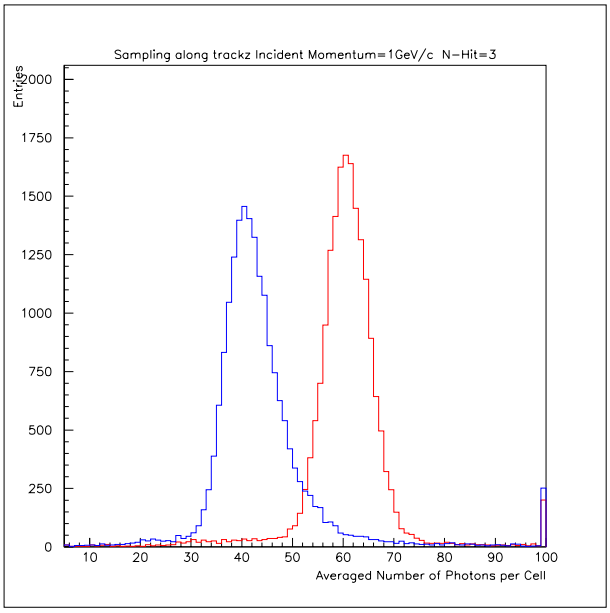

Figure 2: The average energy deposit per cell for 1 GeV/c pions (blue) and 1 GeV/c protons (red).