

Status Report of Neutral Kaon photo-production study using Neutral Kaon Spectrometer 2 (NKS2) at LNS-Tohoku(I. Nuclear Physics)

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Status Report of Neutral Kaon photo-production study using Neutral Kaon Spectrometer 2 (NKS2) at LNS-Tohoku

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§1. Introduction

So far the elementary photo-strangeness production process has been intensively studied based on the high-quality data of the charged kaon channel, $\gamma + p \rightarrow K^+ + \Lambda$ (Σ^0). However, there were no reliable data for the neutral kaon channel $\gamma + n \rightarrow K_S^0 + \Lambda$ and the theoretical investigations suffer seriously from the lack of the data. In order to have reliable data for the neutral kaon photo-production data, we have been putting an effort to measure the $\gamma + n \rightarrow K_S^0 + \Lambda$ process in the $\pi^+ \pi^-$ decay channel, using a liquid deuterium target and a tagged photon beam in the threshold region at Laboratory of Nuclear Science, Tohoku University. We have already taken exploratory data quite successfully with use of Neutral Kaon Spectrometer (NKS) at LNS-Tohoku in 2003 and 2004.

We intend to extend the previous experiment by considerably upgrading the original neutral kaon spectrometer to a completely new neutral kaon spectrometer (NKS2), fully replacing the spectrometer magnet, tracking detectors and all the trigger counters. The new spectrometer NKS2 has significantly larger acceptance for neutral kaons compared with NKS, particularly covering forward angles, and much better invariant mass resolution. The estimated acceptance of NKS2 is about 3 to 4 times (depend on momentum and theoretical model) larger for K_S^0 than that of NKS. Additionally, it is about 8 to 10 times larger for Λ . With this advantage, we expect simultaneous measurements of K_S^0 and Λ . Additionally, we plan to measure other strangeness production channels and also Λ hyperon polarization in $\gamma + n$ and $\gamma + p$ reactions.

§2. General setup of the NKS2 Experiment

The NKS2 spectrometer is located on the BM4 beam line of the second experimental hall of Laboratory of Nuclear Science (LNS), Tohoku University (see Fig. 1). The incident beam from LINAC

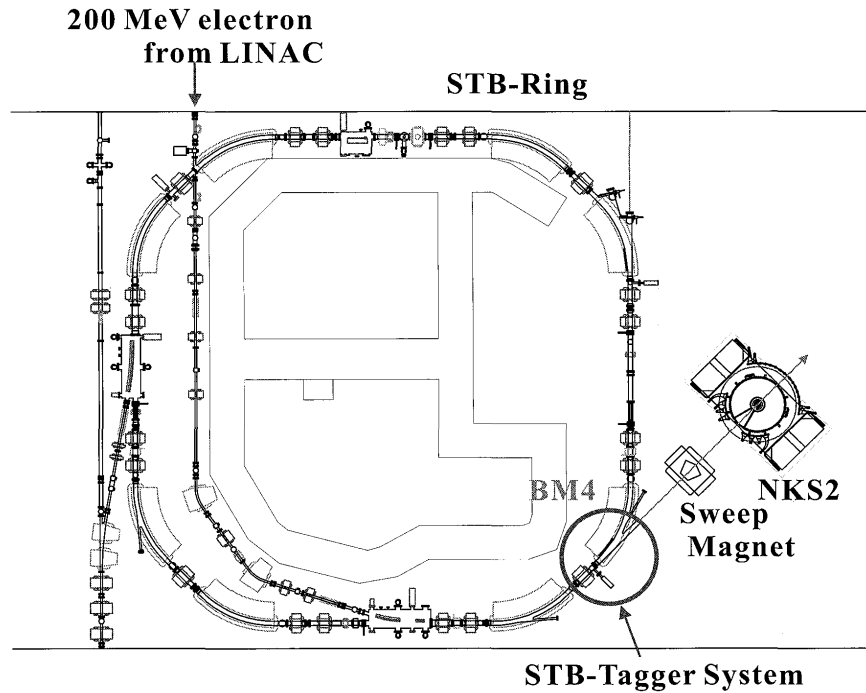


Fig.1. The outline of the second experimental hall of LNS (see text in detail).

has 0.2 GeV of the beam energy and is accelerated up to 1.2 GeV in Stretcher-Booster (STB) Ring. The photon beam is created as bremsstrahlung of electron by a carbon wire at STB Tagger system of Bending Magnet 4 (BM4). There is a dipole magnet which is called the sweep magnet for e^+e^- from photon conversion. The sweep magnet is the same one that was used in the previous experiment NKS.

The spectrometer is placed following the sweep magnet. The main magnet (680 magnet) is a dipole which is renovated from a cyclotron magnet of Cyclotron RI Center of Tohoku University. Detectors of NKS2 are: Inner Hodoscope (IH), Straw Drift Chamber (SDC), Cylindrical Drift Chamber (CDC), Outer Hodoscope (OH), and Electron Veto counter (EV). Detector positions are shown in Fig.2, and 3D views are in Figs. 3 and 4. The detail description of the beam line and the spectrometer will be shown in the following section.

§3. Status of the Experiment

Commissioning runs were carried out in Jan. Mar, Jun., and Sep. 2006. using a carbon target. During those runs, we studied the detector performance, data acquisition system, and trigger rate.

The run of January (17-20) was used to tune the tagging counter and hodoscopes. In the original schedule, the March run (Mar. 7-12) was planned to be used to check the detector system including CDC and hodoscopes. There, however, was an accident of breaking a Mylar window of CDC, therefore this run was used for the trigger study. The CDC was repaired after this beam time and became being ready before the next beam time. In June 6-15, we had two weeks data taking with a natural carbon target. About two third of the beam time was used for the final detector setup: tune of counter gain and

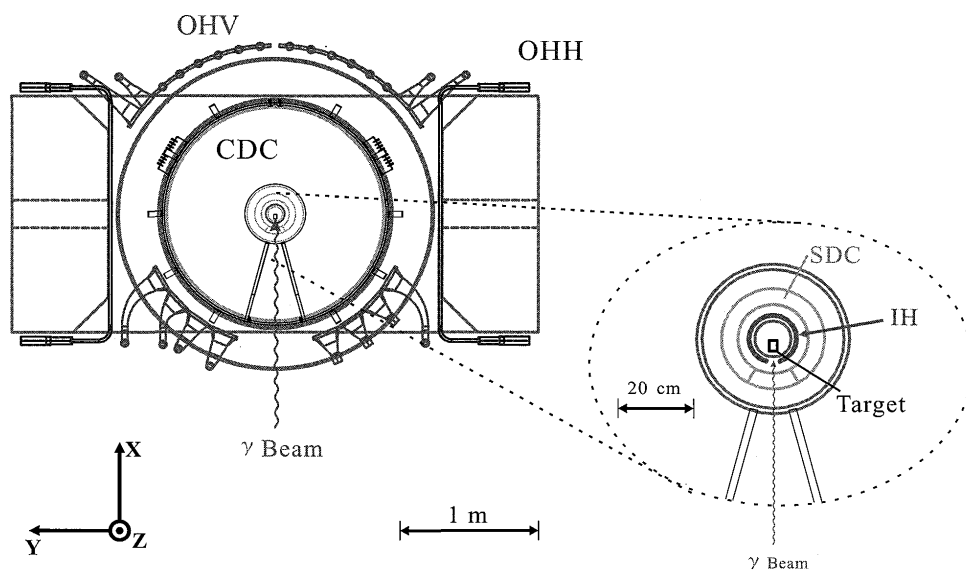


Fig.2. A schematic view of NKS2. The photon beam direction is from bottom to top in the figure. The target holder will be at center of magnet. The detectors are (the order is from center to outer): Inner Hodoscope (IH), Straw Drift Chamber (SDC), Cylindrical Drift Chamber (CDC), Outer Hodoscope (OH, Vertical (OHV) and Horizontal (OHH)), and Electron Veto counter (EV). Note that EV is placed at downstream of OHV but not shown in the figure.

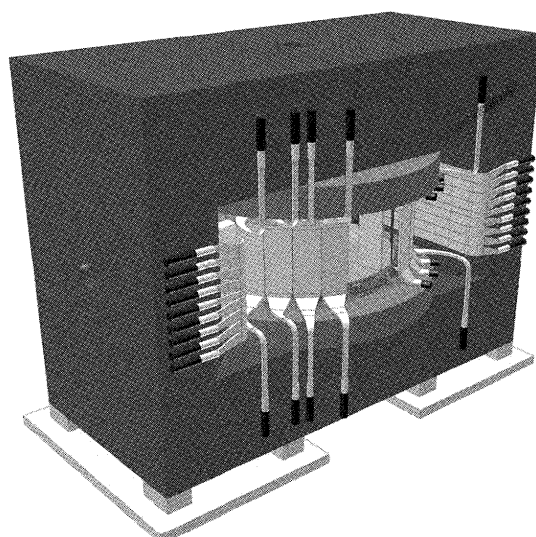


Fig.3. A 3D view of the spectrometer viewed from the upstream of the beam line. We can see a part of OHH on the magnet yoke and OHV around the magnet coil.

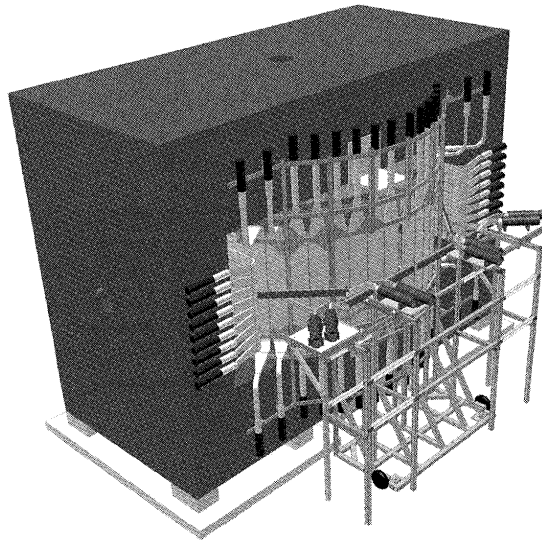


Fig.4. A 3D view of the spectrometer viewed from the downstream of the beam line. There are OHV around the magnet coil and OHH on the magnet yoke. The EV counters are placed following OHV. The OHV and EV counters are supported by aluminum chassis.

threshold of discriminator, noise reduction, fixing some troubles of DAQ, making chambers be ready. Trigger study and data taking were done in the rest of the beam time. The main purpose of the September run (Sep. 25-Oct. 2) was data taking with the carbon target. Additionally, the length of a vacuum pipe between the pair magnet and the target was extended to reject the background from photon conversion. Finally, we started data taking with a liquid deuteron target on November 2.